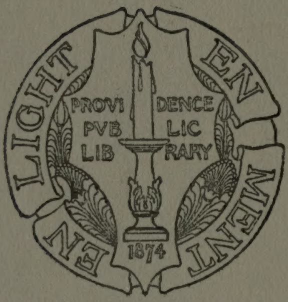


EN LIGHT EN MENT
PROVIDENCE PUBLIC LIBRARY
1874

From the collection of the

Prelinger
Library

San Francisco, California
2008

U.S. DEPARTMENT OF AGRICULTURE
OFFICE OF INFORMATION
DIVISION OF PUBLICATIONS

FARMERS' BULLETINS
Nos. 1676-1700

WITH CONTENTS

PREPARED IN THE INDEXING SECTION

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1933

OCT -9 '34

~~741.79.73~~

605
U5age
v.74

WITHDRAWN RP

CONTENTS

FARMERS' BULLETIN No. 1676.—LUBRICATING-OIL SPRAYS FOR USE ON DORMANT FRUIT TREES:

Page
- Introduction 1
- Lubricating-oil emulsions 2
  - Oil specifications 3
  - Formulas and directions for preparation and use 4
- Miscible oils 10
- Oil sprays for summer use 11
- Mixtures of oil sprays with other materials 11
  - With Bordeaux mixture and copper sulphate 11
  - With lime-sulphur 12
- Injury from oil sprays 12
- Insects for which oil sprays may be used 13
  - San Jose scale 13
  - Oyster-shell scale 14
  - Scurfy scale 14
  - Terrapin scale 15
  - Cottony peach scale 15
  - European red mite and clover mite 15
  - Fruit-tree leaf roller 15
  - Pear psylla 16
  - Apple aphids 17

FARMERS' BULLETIN No. 1677.—PLANTING AND CARE OF LAWNS:

- Introduction 1
- Preparation 1
  - Drainage 1
  - Grading and leveling 2
  - Soils and soil preparation 2
  - Preparation and fertilization of seed bed 3
- Seed and seeding 3
- Vegetative planting 4
- Sodding 4
- Establishing grass on slopes 5
- Lawn grasses 5
- Grasses for airports 9
- Grasses for polo fields, athletic fields, etc 11
- Lawn management 12
  - Fertilizing 12
  - Top-dressing 13
  - Liming 13
  - Rolling 13
  - Watering 13
  - Mowing 15
  - Weeds 15
  - Removing leaves 17
- Renovating old lawns 17
- Pests and diseases 17
  - Insects 17
  - Moles 18
  - Diseases 18

FARMERS' BULLETIN No. 1678.—THE SAFE USE AND STORAGE OF GASOLINE AND KEROSENE ON THE FARM:

- Farm-fire loss from careless use of petroleum and its products 1
- Flammability of gasoline and kerosene 2
- Danger of starting and reviving fires with gasoline or kerosene 2
- The safe way to handle oil lamps, heaters, stoves, incubators, brooders, and lanterns 3

FARMERS' BULLETIN NO. 1678.—THE SAFE USE AND STORAGE OF GASOLINE AND KEROSENE ON THE FARM—Continued.

Page
Hazards of cleaning with gasoline and other volatile liquids ---- 4
Hazards of spraying disinfectants ---- 4
Hazards of using quick-drying paints and lacquers in the home ---- 4
Hazards of gasoline lighting and cooking systems ---- 5
Hazards of automobiles, trucks, tractors, and stationary engines ---- 5
Hazards of pouring gasoline from one container into another ---- 6
Hazards of fuel-oil burners ---- 6
Proper storage of gasoline and kerosene ---- 7
  Gasoline ---- 7
    Placing of tanks ---- 8
    Construction of tanks ---- 9
    Venting of tanks ---- 9
    Pumps ---- 9
    Piping ---- 9
    Overhead shelter ---- 10
  Kerosene ---- 10
  Drawing gasoline and kerosene ---- 10
How to extinguish gasoline and kerosene fires ---- 10
  Foam extinguishers ---- 10
  Carbon dioxide extinguishers ---- 12
  Carbon tetrachloride extinguishers ---- 12
  Loaded-stream extinguishers ---- 13
  Use of sand, soda and sawdust, and water ---- 13

FARMERS' BULLETIN NO. 1679.—POP CORN:

Introduction ---- 1
Popping and other qualities ---- 2
Varieties ---- 3
Seed selection ---- 6
Soils, rotations, and fertilizers ---- 7
Planting and cultivating ---- 8
Harvesting ---- 11
Storing ---- 12
Marketing ---- 14
Insects and diseases ---- 17
Does it pay to grow popcorn? ---- 17

FARMERS' BULLETIN NO. 1680.—FARMERS IN NORTHERN STATES GROW TIMBER AS MONEY CROP:

Value of practical timber-growing examples ---- 1
Farmer draws on timber bank ---- 3
An Indiana farm-woodland success ---- 4
Thinning proved of great value on a Pennsylvania farm ---- 4
An Iowa farm wood lot pays its way ---- 5
Farm woods show substantial profit over a 17-year period ---- 6
Dairy farmer answers timber question ---- 8
Changes cutting tactics—finds woods farming pays ---- 8
Farmer develops paying timber plan ---- 11
The farm woods provide timber for a barn ---- 13
Farm woods yield third crop of construction timber ---- 15
Farmer tells story of his woods ---- 15
Farming the woods ---- 16
Timber pays farmer over long period ---- 16
Farmer handles timber as a crop ---- 17
More dollars than expected ---- 18
Cash income of $5.83 an acre yearly ---- 18
Home-grown lumber and fuel pay interest on investment ---- 20
Finds timberland profitable—buys more ---- 21

FARMERS' BULLETIN NO. 1681.—ADJUSTING CORN BELT FARMING TO MEET CORN-BORER CONDITIONS:

Introduction ---- 1
Area studied ---- 3

FARMERS' BULLETIN NO. 1681.—ADJUSTING CORN BELT FARMING TO MEET CORN-BORER CONDITIONS—Continued.

Page
- Importance of corn in the organization of Corn Belt farms 4
  - Acreage, production, and value of crops 4
  - Acre value of corn 6
  - Labor used in producing corn and other crops 6
- Supply of cash crops grown in the Corn Belt in relation to consumption requirements 7
  - Wheat 7
  - Rye 9
  - Sugar beets 9
  - Potatoes 10
  - Tobacco 10
  - Fruits and vegetables 11
  - Soybeans 11
  - Other crops 12
- Possible effect of corn-borer infestation on farm organizations 12
- Control of the corn borer 13
- Adjustments for corn borer control 16
  - Suggested adjustments for corn-borer control on a grain farm 17
  - Suggested adjustments for corn-borer control on a livestock farm 22
- Factors affecting cost of control 26

FARMERS' BULLETIN NO. 1682.—USEFULNESS OF BIRDS ON THE FARM:

- Introduction 1
- Combined attacks on pests 1
- Daily warfare on insects 4
- Our bird population 4
  - Upland game birds 4
  - Birds of prey 5
  - Cuckoos and woodpeckers 7
  - Nighthawks and humming birds 8
  - Flycatchers 8
  - Jays, crows, and ravens 9
  - Blackbirds 9
  - Sparrows 9
  - Other insect eaters 9
- Public attitude toward birds 13

FARMERS' BULLETIN NO. 1683.—MEASURING WATER IN IRRIGATION CHANNELS:

- Introduction 1
- Weirs 1
  - Construction and setting 2
  - Measurement 4
  - Limitations of weirs 7
- Parshall measuring flume 8
  - Free flow 9
  - Submerged flow 11
  - Setting and size 13
  - Construction 14
  - Stilling wells and gauges 15
- Velocity of approach 16
- Loss of head 17

FARMERS' BULLETIN NO. 1684.—GAME LAWS FOR THE SEASON 1931–32: A SUMMARY OF FEDERAL, STATE, AND PROVINCIAL STATUTES:

- Introduction 1
  - Proclamation of the President 1
- Federal wild-life refuges 2
- Review of legislation of 1931 3
  - Federal regulations 3
  - State and provincial legislation, 1931 3
- Federal laws relating to migratory birds 8
  - Open seasons under Federal regulations 8
  - Bag limits and other provisions under Federal regulations 10

FARMERS' BULLETIN No. 1684.—GAME LAWS FOR THE SEASON 1931-32: A SUMMARY OF FEDERAL, STATE, AND PROVINCIAL STATUTES—Continued.

Page
- Summary of laws relating to seasons, licenses, limits, possession, transportation, and sale 12
  - State laws 13
  - Canada 44
  - Newfoundland 48
  - Mexico 49
- Imported game and game raised in captivity 49
- Field service, Division of Game and Bird Conservation, Bureau of Biological Survey 52

FARMERS' BULLETIN No. 1685.—FUR LAWS FOR THE SEASON 1931-32:

- Steadily declining fur catch 1
- Review of legislation of 1931 2
  - Federal regulations for Alaska 2
  - State laws 2
- Summary of laws 5
  - Federal laws 5
  - Laws of States 6
  - Laws of Canada 25
  - Laws of Newfoundland 29
  - Laws of Mexico 29
- United States game protectors of the Bureau of Biological Survey 30

FARMERS' BULLETIN No. 1686.—COMMON ERRORS IN COTTON PRODUCTION:

- Mistakes that interfere with progress 1
- Causes of deterioration 3
- General measures of improvement 4
  - Changing the method of buying cotton 4
  - Organizing 1-variety communities 5
- Some causes of inferior cotton 7
  - Planting poor seed 7
  - Planting on price conjectures 9
  - Changing the seed 10
  - Planting too many varieties 11
  - Failure to test varieties 12
  - Misleading claims for varieties 13
  - Propagating hybrids 14
  - Planting unsuitable land 14
  - Planting too early 14
  - Thinning too early 15
  - Spacing too wide 15
  - Picking too late 17
  - Breeding weevils in the fall 18
  - Mixing seed at public gins 19
  - Ginning too close 21
  - Ginning too wet or too dry 23

FARMERS' BULLETIN No. 1687.—REMOVING SPRAY RESIDUE FROM APPLES AND PEARS:

- Introduction 1
- Relation of spray residue removal to spraying practices 2
- Relation of maturity to fruit cleaning 4
- Cleaning fruit by wiping or brushing 5
- Cleaning fruit by solvent methods 7
  - Washing with hydrochloric acid 9
  - Washing with alkaline solvents 12
  - Warming the washing solution 13
  - Additional ingredients in the washing solution 16
  - Rinsing the fruit 17
  - Drying the fruit 18
- Effect of cleaning methods on keeping quality 19
- Types of washing equipment 22
  - Paddle washer 22
  - Dipping tanks 28
- Cost of removing spray residue 31

FARMERS' BULLETIN NO. 1688.—INSECT ENEMIES OF THE COTTON PLANT: Page

- Insect cotton pests of greatest importance 1
  - The boll weevil 1
  - The Thurberia weevil 4
  - The cotton leaf worm 4
  - The bollworm 6
  - The cotton flea hopper 7
  - The cotton aphid 9
  - The pink bollworm 11
  - The cotton-leaf perforator 14
  - The red spider 15
- Miscellaneous insect pests of cotton 16
  - The cotton square borer 16
  - The yellow-striped army worm 17
  - The cotton stainer 17
  - The cotton plant bug 18
  - The tarnished plant bug 18
  - The cotton dauber 19
  - The garden webworm 19
  - The salt-marsh caterpillar 20
  - The fall army worm 20
  - The cowpea curculio 22
  - May beetles 23
  - Grasshoppers 23
  - Cutworms 24
  - Sharpshooters 24
  - The corn root aphid 25
  - Wireworms 25
- General considerations 26
- Summary of control measures 27

FARMERS' BULLETIN NO. 1689.—GRAPE DISTRICTS AND VARIETIES IN THE UNITED STATES:

- Introduction 1
  - Vinifera type 1
  - American euvitis type 3
  - Muscadine type 3
- Soils 4
- Vineyard sites 4
- Planting and cultural methods 6
  - Vinifera vineyards 6
  - American euvitis vineyards 8
  - Muscadine vineyards 8
  - Tools and implements 8
- Districts and suitable varieties 9
  - District no. 1 10
  - District no. 2 11
  - District no. 3 11
  - District no. 4 12
  - District no. 5 12
  - District no. 6 13
  - District no. 7 13
  - District no. 8 13
  - District no. 9 14
  - District no. 10 14
  - District no. 11 14
  - District no. 12 14
  - District no. 13 15
- Brief description of the varieties 15
  - Vinifera type 16
  - American euvitis type 20
  - Muscadine type 31

FARMERS' BULLETIN NO. 1690.—PLOWING WITH MOLDBOARD PLOWS:

- Plowing equipment 1
  - Horse plows 1
  - Tractor plows 2

FARMERS' BULLETIN NO. 1690.—PLOWING WITH MOLDBOARD PLOW—CON.

Plowing equipment—Continued. Page
- Two-way plows 2
- Plow bottoms 3
- Accessories for clean plowing 3

Getting ready for the field 6
Plowshares 6
Fitting and setting the attachments 8
Field adjustments 12
- Horse plows 12
- Tractor plows 14

Field practices 18
- Laying out fields 18
- Plowing speeds 18

Clean plowing 19
- Choice of equipment 19
- Covering attachments 19
- Practices that promote clean plowing 21
- Precautions to be taken after plowing 22

FARMERS' BULLETIN NO. 1691.—HOW TO CONTROL GRASSHOPPERS IN CEREAL AND FORAGE CROPS:

Principal kinds of injurious grasshoppers 1
Conditions favorable to outbreaks of grasshoppers 4
Life histories and development of grasshoppers in general 4
Natural enemies 6
Control measures 6
- Destroying grasshopper eggs 6
- Using poisoned bait 7
- Additional suggestions for control 11

Organizing for grasshopper control 12

FARMERS' BULLETIN NO. 1692.—BEAN DISEASES AND THEIR CONTROL:

The bean industry and losses from disease 1
Diseases of garden and field beans 2
- Anthracnose 2
- Bacterial blight 5
- Mosaic (curly leaf) 9
- Rust 12
- Root rots 15
- Root knot 17
- Curly top 18
- Baldhead (snakehead) 19
- Powdery mildew 20
- Ashy stem blight 21
- Sun scald 22
- Angular leaf spot 23

Diseases of lima beans 23
- Downy mildew 23
- Pod blight 24
- Bacterial spot 25
- Yeast spot 26
- Baldhead (snakehead) 27
- Ashy stem blight 27

Diseases of garden and lima beans found in transit 27

FARMERS' BULLETIN NO. 1693.—GROWING CHRISTMAS HOLLY ON THE FARM:

Characteristics of American and English hollies 1
- General appearance 3
- Male and female trees 4
- Growth rate 5

Sections adapted to holly growing 6
Soil conditions and sites suitable for holly growing 6
Management of woodland areas containing American holly 7
Obtaining holly stock for planting 8
- Wild seedling stock 8

FARMERS' BULLETIN No. 1693.—GROWING CHRISTMAS HOLLY ON THE FARM—Continued.

- Obtaining holly stock for planting—Continued. Page
  - Reproduction from seed 9
  - Vegetative propagation 10
  - Transplanting 12
- Details of establishing the plantation 13
  - General considerations 13
  - Cultivation 14
  - Soil fertility and fertilizer 14
  - Spacing the trees 14
  - Planting recommendations 15
  - Special caution 16
- Harvesting holly 16
- Traffic in Christmas holly 17
- Shipment of holly 19
- Marketing holly 20
- Other hollies and holly-like plants 21

FARMERS' BULLETIN No. 1694.—DRESSING AND PACKING TURKEYS FOR MARKET:

- Losses through faulty methods 1
- Shall dressing be done at home? 2
- Care in handling live turkeys 2
- Selecting turkeys for market 3
- Feeding before killing 4
- Equipment for dressing 5
- How to bleed and kill turkeys 6
- How to pick turkeys 8
- How to clean the carcass 10
- How to wrap heads 11
- How to sew torn skin 12
- How to remove crops 15
- Precooling 16
- Saving the feathers 17
- Hauling to market 18
- Grading 19
- Weighing and shrinkage 19
- Boxes and barrels 20
- Box and barrel linings 22
- Box packing 23
- Nailing and strapping boxes 24
- Barrel packing 25
- Marking the packages 25
- Sharp freezing 26
- Shipping invoices 27
- Car loading 27
- A final word 28

FARMERS' BULLETIN No. 1695.—PREPARING APPLES FOR MARKET IN BARRELS AND BASKETS:

- Changing conditions 1
- Harvesting 1
  - Time of picking 2
  - Number of pickings 2
  - Method of picking 3
  - Picking utensils 3
  - Ladders 5
  - Basis on which pickers are paid 5
  - Handling from tree to packing table 5
- Grading and packing 6
  - Grading tables 7
  - Sizing and sizing machines 9
  - Additional equipment for sizing machines 12
  - Removing spray residue 14
  - Power 14
  - Conveyors 14

FARMERS' BULLETIN No. 1695.—PREPARING APPLES FOR MARKET IN BARRELS AND BASKETS—Continued.

Grading and packing—Continued. Page
Packing the barrel 14
Packing the bushel basket 18
Marking the containers 22
Packing houses 22
Location 24
Lighting 25
Storage accommodations 26
Ventilation 26
Suggested floor plans 26
Hauling 32
Loading in cars 32
Cold storage 33
Grading laws and inspection 34

FARMERS' BULLETIN No. 1696.—DECIDUOUS FRUIT IMPROVEMENT THROUGH TREE-PERFORMANCE RECORDS:

Variations in deciduous-fruit trees 1
Classification of variations 2
Searching for bud variations 6
Obtaining individual-tree records 7
Individual-tree numbers 8
Record forms 10
Field records 11
Performance-record periods 12
Assembling data from field records 12
Using individual-tree records 14
Isolating and propagating superior strains 15
Locating unprofitable trees 15
Making progeny tests of selected parent trees 15
Comparing cultural practices 16
Establishing reliable commercial sources of propagating material 17

FARMERS' BULLETIN No. 1697.—USING SOIL-BINDING PLANTS TO RECLAIM GULLIES IN THE SOUTH:

Use of black locust and other trees 2
Use of vines and creeping plants 9
Use of grasses 14

FARMERS' BULETIN No. 1698.—HEATING THE FARM HOME:

Factors affecting health and comfort 1
Requirements of a heating plant 2
Proper size of heater 2
The chimney flue 3
Types of heating systems 4
Fireplaces and stoves 4
Warm-air system 5
Hot-water system 8
Steam system 10
Types of boilers 11
Installation costs of various systems 12
Hot-water supply 12
Operation of the heating plant 12
Rules for preparing equipment 13
Kinds of fuel 13
Rules for burning large-size anthracite 13
Rules for burning coke with anthracite pea or buckwheat 13
Rules for burning wood with anthracite pea or buckwheat 14
Rules for burning bituminous coal 14
Temperature regulators 14
Ways of conserving heat 14
Reducing window and door leakage 14
Reducing heat losses through walls and roofs 15

Farmers' Bulletin No. 1699. Growing Root Crops for Livestock: Page
Soil and climatic relations 1
Varieties 2
Growing the crop 3
Preparing the seed bed 3
Fertilizing and liming 3
Time of seeding 4
Rate of seeding 4
Method of seeding 4
Cultivation 5
Thinning 5
Harvesting 6
Storing 6
Composition 7
Feeding 7
Preparation of roots for feeding 8
Root crops for cattle 9
Root crops for sheep 9
Root crops for horses 10
Root crops for hogs 10
Root crops for poultry 10
Cost of production 11
Yields 11
Insect pests 11
Diseases 12

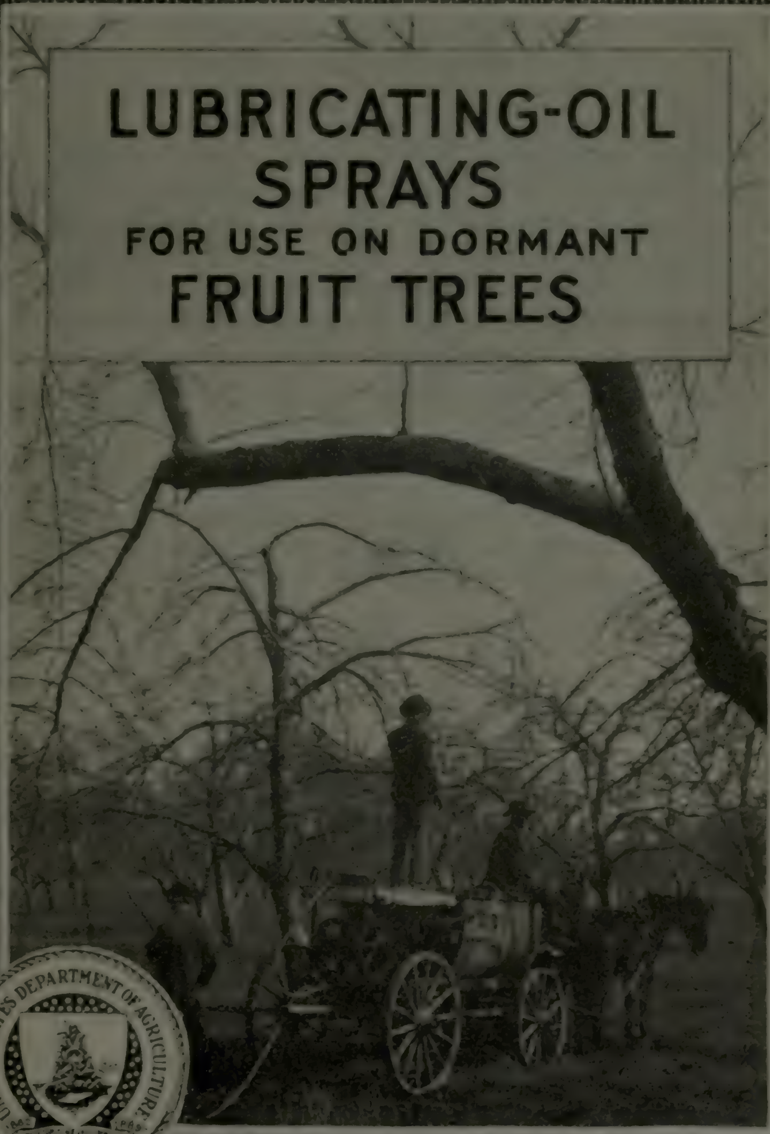
Farmers' Bulletin No. 1700.—Marketing Hay by Modern Methods:
Methods of marketing 1
Consignment method 1
Straight-sale method 4
Trade rules 5
Statements of terms 5
Confirmation letter 8
Living up to the terms 8
When and where to sell 11
Using market reports 13
Making the shipment 15
Preparing bills of lading 15
Forwarding bills of lading 17
Using sight and arrival drafts 18
Making the invoice 23
Rebilling cars 23
Loss and damage claims 24
Preparation of shippers' claims 24

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1676

LUBRICATING-OIL SPRAYS

FOR USE ON DORMANT FRUIT TREES



LUBRICATING-OIL EMULSIONS have in recent years come into very general use in the dormant and delayed-dormant spraying of deciduous-fruit orchards and yard trees in most parts of the country and to a lesser extent for trees in foliage. This bulletin gives directions for the preparation, storage, and use of lubricating-oil emulsions, describes the different emulsifiers which have been found suitable for the preparation of these sprays, and gives specifications to guide the grower in selecting the proper kind of oil for use in orchard spraying. The orchard insects which may be readily controlled by the use of oil are briefly discussed, and the proper strength of lubricating-oil emulsion for the control of each species is indicated.

Washington, D. C. **Issued September, 1931**

LUBRICATING-OIL SPRAYS FOR USE ON DORMANT FRUIT TREES

By A. L. Quaintance, formerly *Associate Chief of Bureau, in Charge*, E. J. Newcomer, *Senior Entomologist*, and B. A. Porter, *Entomologist, Division of Deciduous Fruit Insects, Bureau of Entomology*[1]

CONTENTS

Page
Introduction 1
Lubricating-oil emulsions 2
  Oil specifications 3
  Formulas and directions for preparation and use 4
Miscible oils 10
Oil sprays for summer use 11
Mixtures of oil sprays with other materials 11
  With Bordeaux mixture and copper sulphate 11
  With lime-sulphur 12
Page
Injury from oil sprays 12
Insects for which oil sprays may be used 13
  San Jose scale 13
  Oyster-shell scale 14
  Scurfy scale 14
  Terrapin scale 15
  Cottony peach scale 15
  European red mite and clover mite 15
  Fruit-tree leaf roller 15
  Pear psylla 16
  Apple aphids 17

INTRODUCTION

WHEN USED IN ORCHARD SPRAYING, oils should be mixed with water, in order that they may be applied economically and with safety to the trees. While not soluble in water, oil may be more or less evenly distributed in water by a process known as emulsification, in which the oil is broken up into extremely fine droplets (fig. 1), similar to the globules of butterfat in milk. The emulsifier holds the oil globules apart and prevents the separation of the oil from the water.

Two general classes of petroleum oil sprays are usually recognized, miscible oils and oil emulsions, the distinction being based on the character of the stock, or concentrated material. In the preparation of stock emulsions the oil is broken up into fine globules, and water is included in the mixture in proportions ranging up to 50 per cent. These stock emulsions vary in consistency from that of thin cream to that of a thick, jellylike paste. In the case of a miscible oil, the emulsifier is dissolved in the oil, and the concentrated material is prepared with very small quantities of water, which results in a clear stock, similar in general appearance to ordinary lubricating oil. When diluted, however, emulsions and miscible oils are very similar, the chief difference being that the oil droplets in a miscible oil are as a rule considerably smaller than those found in a diluted emulsion.

---

[1] The experimental information on which this bulletin is based has been obtained by a number of workers in the Bureau of Entomology and elsewhere. Apparently the first experiments with lubricating-oil emulsions for the control of insects attacking deciduous fruits were conducted at Bentonville, Ark., by A. J. Ackerman, in 1921-22. Since that time work with lubricating-oil sprays has also been conducted by the Bureau of Entomology at Yakima, Wash., by E. J. Newcomer and M. A. Yothers; at Fort Valley, Ga., by O. I. Snapp, C. H. Alden (resigned), and H. S. Swingle (resigned); at Vincennes, Ind., by B. A. Porter and R. F. Sazama; at Sligo, Md., by E. H. Siegler and Luther Brown; and at Washington, D. C., by C. H. Richardson (resigned) and R. C. Burdette (resigned). R. C. Roark, of the Bureau of Chemistry and Soils, and E. L. Griffin, of the Food and Drug Administration, have cooperated in the chemical and certain other technical phases of the oil investigations.

In dealing with oil sprays, the grower should keep in mind the fact that the dispersal of oil in water is in many cases a very temporary condition and that at the first opportunity the oil and the water may follow their normal tendency and separate into distinct layers, which do not readily mix again. This separation of oil, or "breaking" of the emulsion, renders the spray unsuitable for use, since the greater part of the liquid in the tank then contains insufficient oil for proper effectiveness, while the remainder of the tank load contains such a high proportion of oil that injury to the treated plants may result.

A complete separation of the oil as just described should not be confused with "layering," or "creaming," which occurs with many oil sprays, usually after they are diluted. Layering is analogous to the rising of cream on milk, the cream in this case consisting of the globules of oil, accompanied by the emulsifier and any other solid or semisolid materials which may be present. While creaming often results in apparently distinct layers of materials, a moderate amount of stirring or agitation restores the entire mixture to its original uniform condition.

When diluted in the spray tank, the different oil sprays vary greatly in their tendency to separate, or break down. In general, the miscible oils are more stable than the emulsions.

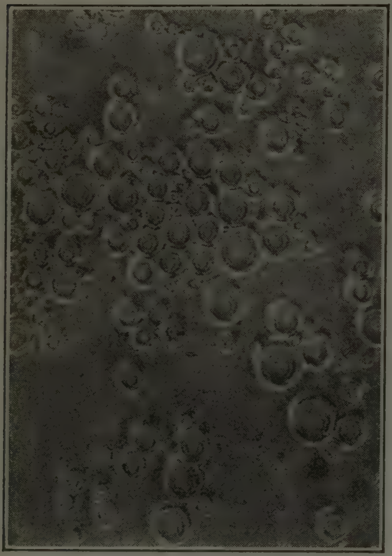


FIGURE 1.—Diluted oil emulsion, magnified 400 times to show the tiny globules of oil floating in the water

LUBRICATING-OIL EMULSIONS

In recent years it has been found that emulsions prepared from certain cheap lubricating oils are remarkably effective at low concentrations, and these efficient and economical oil sprays have come into very general use in the control of the San Jose scale and of certain other insects in the deciduous-fruit orchards in many parts of the country. For a few years after lubricating-oil emulsions were first introduced, many orchardists prepared their own stock material, but at present most of it is made by insecticide manufacturers, or by small local plants supplying near-by growers. A number of orchard men, however, are still making their own stock emulsion, utilizing farm labor which would otherwise be less profitably employed during slack periods through the winter months. For the benefit of such growers and others, detailed directions are here given for the preparation of a number of different kinds of oil emulsion.

The making of lubricating-oil emulsions, as well as their use in the orchard, should be carefully supervised, in order that the oil may be properly emulsified and properly diluted. If a scum of free oil is found in the spray tank, the cause should be determined, and the condition corrected before any further spraying is done. A broken emulsion, in which the oil has risen to the top in a separate layer, is unfit for spraying purposes.

OIL SPECIFICATIONS

The oils which have been found suitable for the dormant spraying of deciduous-fruit trees are the lighter lubricating oils, such as are used in slow-moving bearings, and some of the oils ordinarily used for floor dressings. Such oils have sometimes been referred to as "red engine" oils, but this term is too indefinite for use when buying oil for the control of insect pests. Certain technical specifications will describe more definitely the type of oil which has been found most satisfactory. The important properties appear to be viscosity[2] and volatility.[3]

The viscosity which an oil should possess, to be suitable for dormant spraying, seems to vary somewhat in different parts of the country, apparently because of climatic conditions. In northwestern Arkansas oils having a viscosity of about 200 seconds Saybolt have been found to have the maximum effectiveness, and oils of this viscosity are used by most of the growers in the Ozark fruit districts. Workers in the southeastern part of the United States recommend oils having a viscosity of 125 seconds Saybolt or more. In the more northern fruit sections oils having a viscosity of 90 to 100 seconds Saybolt seem to give as good results as the more viscous ones, possibly because the lower temperatures which normally prevail during the dormant season permit the oil to remain longer on the trees. For summer spraying, oils having a viscosity of a little less than 90 seconds Saybolt are often used.

The volatility should be low; in other words, the oils should be of such quality that they will not evaporate too quickly.

A third specification, known as the unsulphonated residue, indicates the degree of refinement of the oil. This is expressed as a percentage, a high value indicating a high degree of refinement. While this property is of significance chiefly in connection with oils for summer spraying, the recommendations in the Northwest[4] call for oils showing an unsulphonated residue of not less than 50 per cent. This is broad enough to include the majority of the lubricating oils in common use for spraying purposes.

The base from which the oil is derived, either asphalt or paraffin, appears to be of no special importance.

---

[2] Viscosity is specified technically in seconds—the length of time it takes a given quantity of oil to pass through a given opening under standard conditions. (Most frequently determined in the Saybolt universal viscosimeter at 100° F.)

[3] Volatility is measured by the percentage of the oil which evaporates under certain standard conditions.

[4] Recommendations made by the western cooperative oil-spray project (a group of investigators in the Northwest) for 1931.

FORMULAS AND DIRECTIONS FOR PREPARATION AND USE

SOAP-OIL EMULSIONS

Probably the most widely known lubricating-oil emulsion is that prepared according to a formula developed by W. W. Yothers, of the Bureau of Entomology, for use in the control of citrus pests, and first found effective in the control of the San Jose scale by A. J. Ackerman, also of the Bureau of Entomology. This formula utilizes soap as the emulsifier, and heat is necessary for its preparation.

BOILED SOAP-OIL EMULSION

Lubricating oil	1 gallon.
Potash (potassium) fish-oil soap	1 pound.
Water	½ gallon.

The soap ordinarily used is a liquid potash fish-oil soap containing 30 per cent or more of soap by weight. Potash soap is more satisfactory than soda soap, because it does not become hard on cooling. The water used should be soft if possible, like rain water.

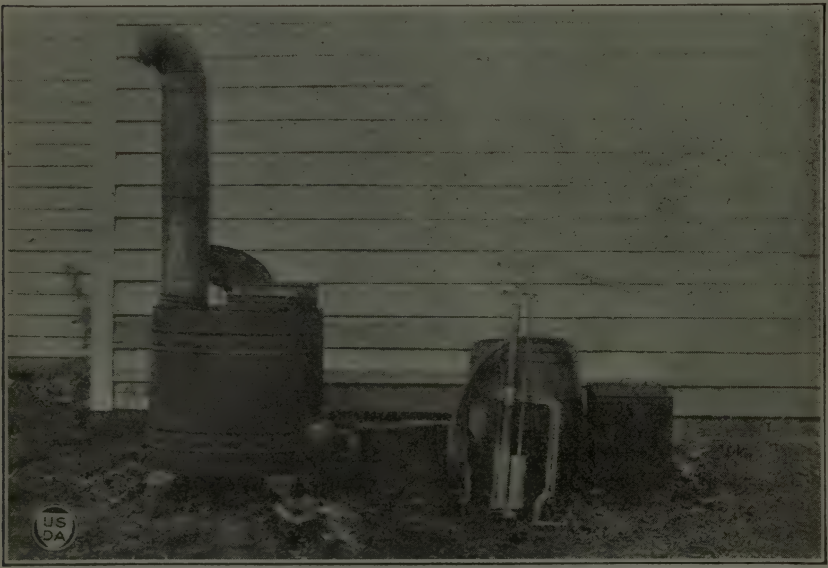


FIGURE 2.—Equipment which was used in preparing oil emulsion for the first experiments with lubricating-oil emulsion on deciduous orchard trees, and suitable for making small quantities of material

The ingredients are mixed together, the whole brought to a boil, and then, while still hot, pumped at least twice through a small opening, such as that in a spray gun or a very coarse disk nozzle. The emulsion should be pumped from one container into another, rather than back into itself, so that all of the material will pass through the pump. A bucket pump (fig. 2), vigorously used, will give a good emulsion, although for making large quantities a power-driven pump is of course desirable. The emulsions made with the larger pumps are usually more stable than those made with a bucket pump, and will keep for longer periods of time, since the greater pressure breaks the oil up into finer droplets. Hot oil is very destructive to fiber or rubber pump packing, and if large quantities of emulsion are to be prepared, metal packing will be necessary. Various sources of heat have been successfully employed. Some manufacturers use a steam-jacketed copper kettle, while others use live steam, introduced into the mixture through a coil in the bottom of the cooking vat. (Fig. 3.)

Certain modifications of the foregoing formula have been suggested from time to time. In some cases the quantity of soap has been increased to insure stability when slightly hard water must be used for diluting the emulsion. If very hard water must be used for spraying, however, some other means of preventing the breaking of the emulsion must be employed. Another modification has been a reduction in the quantity of water used, the chief advantages being a saving in storage space and a lessening of the danger of freezing. The water content of a stock emulsion made according to this formula may be reduced to 25 per cent (one-fourth of a gallon of water for each gallon of oil); beyond this point certain difficulties may develop.

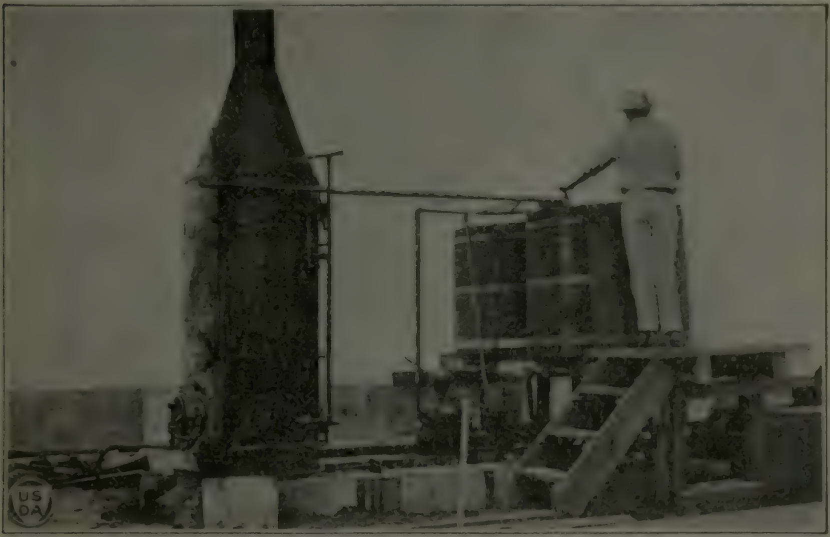


FIGURE 3.—Equipment suitable for the preparation of oil emulsion on a commercial scale. The cooking is done by live steam from the boiler

The standard formula ordinarily results in a stock containing approximately 66 per cent of actual oil by volume,[5] although some allowance has to be made for the manner of manufacture. If the stock is cooked in a shallow container over an open fire, excessive evaporation may unduly reduce the volume of water, and thus increase the proportion of oil. The use of live steam causes a slight increase in the quantity of water present. The pumping sometimes incorporates more or less air into the mixture, but the emulsion usually shrinks to normal volume on standing and cooling.

---

[5] Throughout this bulletin the oil content both of stock emulsions and of diluted oil sprays is expressed as the percentage of oil by volume.

COLD-STIRRED SOAP-OIL EMULSIONS

Several formulas have been developed for the preparation of soap-oil emulsions without the use of heat, the ingredients being merely stirred together. No water, except that present in the fish-oil soap, is used in these formulas. This type of emulsion has been used by a number of growers, who have found it quite satisfactory. Two formulas will be given.

Resin fish-oil soap emulsion[6]

Lubricating oil	9 gallons (about 65 pounds).
Resin fish-oil soap[7]	1 gallon (about 8 pounds).

Pour the soap into a suitable container, then add a quantity of oil not to exceed one-third of the volume of the soap. Stir the oil rapidly into the soap by means of a paddle until all of the oil has disappeared into the soap, and the mixture has become somewhat stiff. Continue to add successively larger quantities of the oil (each additional quantity of oil never to exceed one-third of the total bulk of the mixture). Stir in thoroughly each addition of oil and do not add more until the emulsion has a stiff jellylike consistency. This procedure should be continued until the required quantity of oil has been emulsified. This emulsion may be made in a small way with a bucket and paddle; for quantity production a power mixer is desirable. (Fig. 4.)

The stock emulsion made according to this formula contains approximately 90 per cent of oil by volume. It should be stored in airtight containers. Any free oil found on the surface can be stirred into the mixture without difficulty. In diluting this jellylike stock, work small quantities of water into it at the start, instead of putting the stock material directly into large quantities of water.

Cold-stirred soap-oil emulsion

Lubricating oil	1 gallon.
Soap (potash fish-oil soap, 30 per cent actual soap)	1 pound.

Stir the soap and oil together as directed above.

USE OF SOAP-OIL EMULSIONS WITH HARD WATERS

When a soap-oil emulsion is diluted with hard water, which is the only water available in many orchards, the soap is immediately attacked by the calcium or other mineral salts present, forming insoluble soaps which are then useless as emulsifiers. This liberates the oil, which rises to the surface in the spray tank. If the water is only slightly hard, the use of a little additional soap in the preparation of the emulsion will often overcome the difficulty. The emulsions prepared with resin fish-oil soap are more resistant to the action of hard water than those made according to the standard formula, but even these break down in some hard waters.

---

[6] A more complete discussion of this emulsion will be found in a mimeographed circular, E-277, by E. H. Siegler and Luther Brown, issued by the Bureau of Entomology in March, 1930.

[7] A resin fish-oil soap much used in preparing these emulsions has approximately the following composition: Fish-oil soap, 16 per cent; resin soap, 47 per cent; water, 37 per cent.

The difficulty with hard water has been successfully overcome in many eastern and middle-western fruit districts by making a weak Bordeaux mixture (½–½–50) with the water used in diluting the emulsion, before the oil-emulsion stock is added. When the soap is eliminated by the action of the hard water, the Bordeaux acts as a substitute emulsifier, and maintains the emulsion. The resulting mixture layers rather rapidly, however, and a moderate amount of agitation is needed to insure a uniform emulsion. The agitation provided by present-day sprayers is more than adequate for this purpose. The use of Bordeaux mixture to overcome the action of hard water on soap emulsions involves bothering with additional ingredients, but the growers in some eastern and middle-western districts have adopted this practice. In other districts, especially in the Northwest, the tendency has been toward the use of the soapless emulsions.

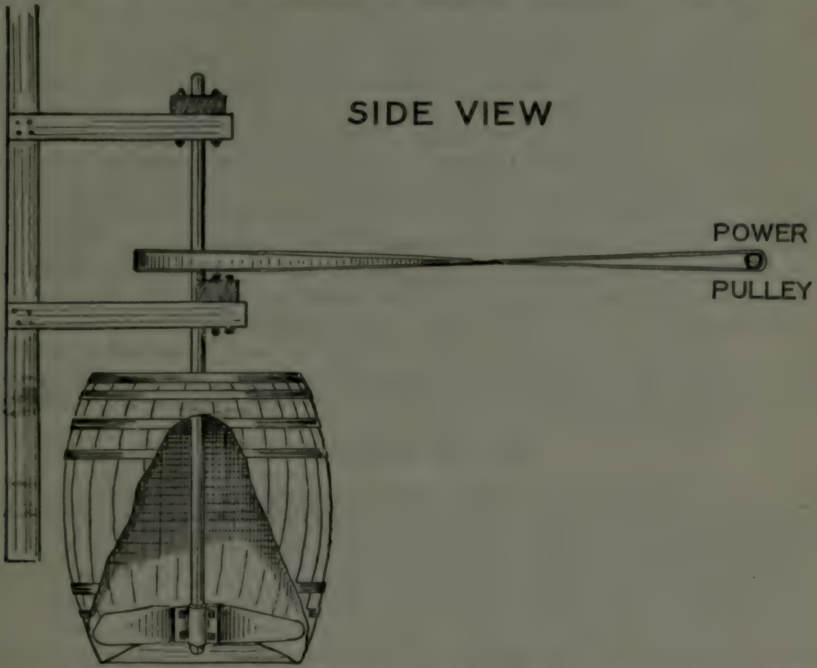


FIGURE 4.—Equipment used for the preparation of resin fish-oil soap-oil emulsion on a small commercial scale. This sort of equipment is also suitable for making other cold-stirred soap-oil emulsions. (After Siegler and Brown. See footnote 6)

Sometimes the presence of residues of lime-sulphur or Bordeaux mixture in the spray tank causes oil emulsion to break down in a similar manner as occurs with hard water. All such foreign matter should be washed out of the spray tank before the use of a soap-oil emulsion is attempted.

STORAGE OF SOAP-OIL EMULSION

A well-made soap-oil stock emulsion is stable for a fairly long period, and no difficulty is likely to be experienced if the quantity required for an entire dormant season is stored from fall until spring. A gradual separation takes place, however, and stock emulsions carried over from one year to the next are often in poor condition the second season.

Stock emulsions should be stored in clean containers. Old lime-sulphur barrels should not be used for storing soap-oil emulsions, since it is almost impossible to remove the lime-sulphur so completely that the emulsion will not be broken down by the action of the calcium salts present.

In storing the boiled stock emulsion made according to the Government formula, care should be taken to prevent freezing. While the true freezing point of this emulsion is only a degree or two below 32° F., the stock may often be "undercooled" to a point as low as 25° or even 20° before freezing actually sets in. Frozen emulsions sometimes break down, especially if they are moved about while still frozen. If allowed to thaw out gradually without being disturbed, however, they are seldom seriously damaged. The cold-stirred soap-oil emulsions do not freeze very readily, and may be safely stored at temperatures nearly down to zero.

Boiled lubricating-oil emulsion which has been stored for long periods should be thoroughly stirred before any material is drawn off, since the excess water and soap present tend to settle to the bottom, forming a separate layer.

SOAPLESS EMULSIONS

Certain materials other than soap are very good emulsifiers, and oil sprays prepared with these materials have certain advantages not possessed by those in which soap is used, chiefly that of mixing readily with hard waters. Two of these emulsions were first suggested in this country by workers at the Missouri Agricultural Experiment Station, and are sometimes referred to as "Missouri cold-mixed emulsions." As the name implies, no heat is required in their preparation. These formulas are as follows:

CALCIUM CASEINATE-OIL EMULSION

Lubricating oil	1 gallon.
Calcium caseinate	2 ounces.
Water	½ gallon.

With a small quantity of water, work the calcium caseinate into a thin paste free from lumps; add the remainder of the water and then the oil; pump several times from one container into another through a small opening, such as that in an ordinary spray gun. The preparation of satisfactory cold-mixed emulsions requires greater pressures than are needed in making the boiled soap-oil emulsion, and an ordinary bucket pump is often inadequate for this purpose. Much better emulsions may be made with a power-driven pump. The calcium caseinate should be fresh, since material which has been on hand for long periods is often unsuitable for use as an emulsifier. The stock emulsion prepared according to this formula should be used within a day or two of the time it is prepared; if stored for longer periods, the oil often separates, making it impossible to obtain a uniform emulsion when it is diluted. Some growers use a power sprayer for preparing these emulsions, making up either a day's requirements when starting operations in the morning or enough for each tank load as needed. In preparing large quantities, the material is mixed in the spray tank, pumped into barrels or other containers, and then pumped back and forth until emulsification is complete. For this purpose an overhead suction hose is convenient. In making only enough for a tank load at a time, the quantity of material is usually small enough so that a good emulsion may be made by merely pumping it through the spray nozzle back into itself for a few minutes before filling the tank with water. When small quantities of oil are mixed in this way, a little of the stock mixture may be forced into the air-pressure chamber, and is retained there until the pressure runs down when the tank is about empty. At this point, this concentrated oil flows from the pressure chamber back into the tank and is sprayed out with the last few gallons. This means that for the most of the tank load the oil content of the spray is slightly below the required dilution, while at the very end it is stronger than necessary. Releasing the pressure for a moment after the tank has been filled will overcome this difficulty.

The calcium caseinate-oil emulsions are usually unaffected by hard waters, although in New Mexico it has been found that waters containing large quantities of magnesium salts break down emulsions of this type.

BORDEAUX-OIL EMULSIONS

Lubricating oil	1 gallon.
Copper sulphate	2 ounces.
Hydrated lime	3 ounces.
(or unslaked lime	2 ounces).
Water	½ gallon.

Dissolve the copper sulphate in the greater part of the water. (The copper sulphate should be dissolved in a nonmetal container.) Stir the lime into the remainder of the water, then add it to the copper sulphate solution, stirring vigorously. In other words, prepare a Bordeaux mixture. Add the oil, and pump as outlined for the preparation of the calcium caseinate-oil emulsion. As with the calcium caseinate-oil emulsion, the stock should be used within a few days of the time it is made. Both of these soapless emulsions layer rather rapidly when diluted, and vigorous agitation should be maintained in the spray tank at all times.

Bordeaux-oil emulsion may also be prepared in the spray tank as needed, a tank load at a time. In case additional Bordeaux mixture is being used as a fungicide, the entire quantity of copper sulphate solution and lime may be added to one-third of the tank of water, the raw oil added, and the whole pumped back into itself for a few minutes. The filling of the tank may then be completed.

PROPRIETARY SOAPLESS EMULSIONS

A number of proprietary soapless emulsions have made their appearance on the market, and for the most part these products have given very satisfactory results. Most of them are thick pastes, containing 65 to 85 per cent oil. They should be used at the concentrations recommended by the manufacturers on the label.

DILUTION OF OIL EMULSIONS

The dilutions recommended for lubricating-oil emulsions are usually expressed as percentages of oil, and refer to the content of actual oil, rather than to the proportion of stock used. The recommendations assume that the stock contains some standard proportion of oil—usually 66 per cent. On this basis, to obtain 100 gallons of a 2 per cent diluted spray 3 gallons of stock will be required; for 3 per cent of oil 4½ gallons will be required; for 4 per cent of oil 6 gallons will be required. If the stock material contains more or less oil than the proportion resulting from the use of the standard formula, the proper quantity of stock to use may be ascertained from Table 1.

TABLE 1.—*Dilution table for use of stock lubricating-oil emulsions of different oil contents*

Oil content of stock material (per cent)	Quantity of stock[1] needed to obtain given percentages of oil in 100 gallons of diluted material			
	1 per cent	2 per cent	3 per cent	4 per cent
	Gallons	*Gallons*	*Gallons*	*Gallons*
50	2	4	6	8
55	2	3¾	5½	7½
60	1¾	3½	5	6¾
65	1¾	3¼	4¾	6¼
70	1½	3	4½	5¾
75	1½	2¾	4	5½
80	1¼	2½	3¾	5
85	1¼	2½	3¾	4¾
90	1¼	2¼	3½	4½

[1] Fractions rounded off in each case to next higher one-fourth gallon.

MISCIBLE OILS

A number of reliable and effective proprietary miscible oils are available on the market. These oils differ in composition, and no specific directions will be given here for their use. In most cases the manufacturers recommend their use at 5 per cent or at slightly greater strengths (1 to 20 or 1 to 15), although in some instances the recommendations have been reduced to 3 per cent or 4 per cent (1 to 33 or 1 to 25).

Miscible oils have certain advantages over the emulsions; they are very convenient to use, the mixing operations do not require such close supervision as is necessary with the emulsions, they may be stored indefinitely, and they do not freeze readily.

The relative covering powers of the miscible oils and the lubricating-oil emulsions appear to be approximately equal, according to tests conducted by the Bureau of Entomology.

OIL SPRAYS FOR SUMMER USE

The oil sprays in common use for dormant spraying, when employed at effective strengths, are unsafe on trees in foliage, although in emergency cases certain emulsions of ordinary lubricating oil have been used on apple (but not on peach) with comparatively little injury. In recent years it has been found that highly refined oils of the type used for medicinal purposes, and often referred to as "white," or "crystal," oils, are much less injurious to foliage and fruit than the ordinary lubricating oils, and that the white oils may be used to a certain extent during the growing season. These summer oils are available chiefly in the form of soapless emulsions of the paste type. While favorable results have been reported from the use of these oils under some conditions, injurious effects have been noted in other cases, and the margin of safety appears to be a very narrow one. Further experimental work is needed before general recommendations can be made as to the summer use of white oils in deciduous-fruit orchards.

MIXTURES OF OIL SPRAYS WITH OTHER MATERIALS

WITH BORDEAUX MIXTURE AND COPPER SULPHATE

Practically all oil emulsions, as well as some miscible oils, mix readily with Bordeaux mixture, and such combination sprays are in rather extensive use in some sections in the dormant spraying of peach trees. The Bureau of Plant Industry has found that this combination spray gives satisfactory results in the control of peach leaf curl. In the control of the San Jose scale, however, the addition of full-strength Bordeaux mixture to oil emulsion has been found to reduce to a certain extent the effectiveness of the oil, but this may be overcome by a moderate increase in the strength of the oil. For example, if 2 per cent of oil used alone has been found necessary for the control of the San Jose scale, the addition of full-strength Bordeaux mixture should be compensated for by an increase in the oil content to 2½ or 3 per cent. The oil-Bordeaux combination has also been used to a limited extent on apple in the delayed-dormant application, and is believed to have value at this stage of the development of apple foliage in the control of apple scab. Too little is known about the safety of this practice to recommend its use.

Copper sulphate, at concentrations of 2 pounds to 4 pounds in 50 gallons, also forms a fairly good mixture with most of the oil emulsions, and has been used to a limited extent in the dormant spraying of peach trees, but has in some cases caused injury to peach wood.

When Bordeaux mixture and oil emulsion are combined, the Bordeaux and oil together tend to form a separate layer in the spray tank, although the oil itself does not separate out. Moderate agitation is necessary to overcome this tendency. The copper sulphate-oil emulsion mixture creams very rapidly, and requires vigorous agitation if a uniform spray is to be maintained.

In summer spraying of apple, Bordeaux mixture appears to cause an even greater reduction in the effectiveness of oil in the control of the scale, and if emergency applications for scale control appear necessary during the summer, the oil should be applied separately, and not combined with Bordeaux mixture.

WITH LIME-SULPHUR

Combinations of lubricating-oil emulsions with lime-sulphur have been found very injurious to the foliage of deciduous-fruit trees, and in some cases have caused damage to dormant peach wood. Little is to be gained by the use of such combinations, and their general use is not recommended.

INJURY FROM OIL SPRAYS

While the application of oil sprays during the dormant period has in some cases caused injury to fruit trees, the extensive use of many kinds of oil emulsions for dormant spraying during the last seven or eight years, under all conceivable weather conditions, warrants the statement that there is little danger from the use of a properly prepared oil emulsion or miscible oil while the trees are fully dormant. In the Northwest, a few cases of serious injury to apple trees have apparently resulted from late fall or early winter applications of oil sprays, followed by sudden drops to subzero temperatures. This condition has not been observed, however, when the spraying was done in late winter or early spring, even if followed by very cold weather. As a general precaution, however, many growers do not spray when the temperature is below 40° F., especially along toward night when an unusual drop in temperature seems to be in prospect.

The foliage of fruit trees is of course more subject to injury than the wood, and the application of the less refined oils after the buds begin to swell always involves a certain degree of risk. In the Northwest the application of the less refined oils to apple trees after the buds have commenced to swell have, under some conditions, caused considerable injury to the fruit buds, and in that section the recommendation is made that the dormant spraying be completed before the buds start to swell. In the eastern and middle-western fruit sections applications of properly made oil emulsions or miscible oils during the delayed-dormant period have seldom caused appreciable injury. The danger increases as the foliage pushes out, and after the leaves have reached a length of a half inch the more highly refined oils should be employed if the use of an oil spray is found necessary.

Fears have been expressed from time to time that the continued use of oil sprays over a period of years might ultimately result in cumulative injury. The occurrence of such cumulative injury is very difficult to demonstrate or to disprove, but the healthy condition of thousands of orchards which have received annual dormant applications of oil sprays over a period of eight or more years would indicate that this danger is not a very serious one.

As already indicated, none of the summer or white oils can be considered completely noninjurious to foliage, although some of them have been used without serious consequences.

INSECTS FOR WHICH OIL SPRAYS MAY BE USED

Brief mention will be made of the more common insects which may be controlled by the use of oils sprays, together with the concentrations of oil emulsion needed for effective work. The miscible oils should, in most cases, be used at somewhat greater strengths than those indicated for the oil emulsions; more exact information as to the proper dilution will be found on the label. The mention of an insect pest in this discussion does not necessarily mean that oils are recommended to the exclusion of other sprays; in many cases lime-sulphur or other materials may be used with an equal degree of effectiveness, and under some circumstances may be preferable.

The list of scale insects is by no means a complete one, but includes representatives of most of the important groups. If scale insects not specifically mentioned here become troublesome, the recommendations made for closely similar species will in most cases be found effective.

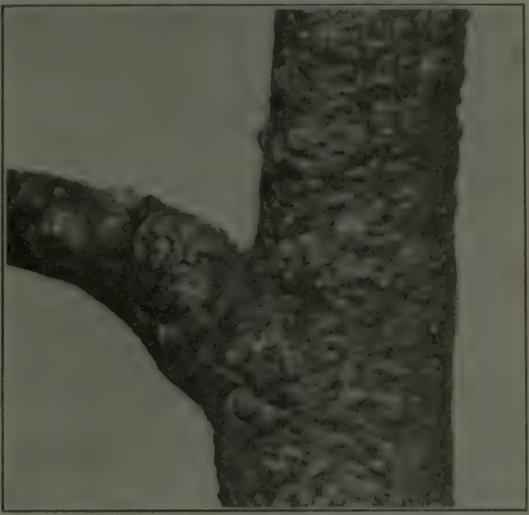


FIGURE 5.—Portion of apple twig encrusted with the San Jose scale. Scales of all ages are shown in the illustration; the largest and the smallest ones perish during the winter. Twice natural size.

SAN JOSE SCALE

The San Jose scale (*Aspidiotus perniciosus* Comst.) (fig. 5) attacks practically all orchard trees, and is well known to most fruit growers. The individuals which happen to be one-third to one-half grown at the close of the season are those which will survive the winter in middle and northern latitudes. The concentration of oil emulsion needed for the control of the San Jose scale seems to vary as between different localities. In the Middle West 2 per cent of actual oil (in the emulsion form) is sufficient if a thorough job of spraying is done. In heavy infestations, however, growers sometimes use 3 per cent of oil in order to be sure of a kill in spots that are only lightly sprayed. In other sections 3 per cent of oil has become the standard recommendation, while in the Pacific Northwest 4 per cent of oil in the form of an emulsion seems to be required for satisfactory results.

In the case of apple, if control has not been obtained during the dormant season, the use of summer oils at 1 or 2 per cent when crawlers are present in numbers is of value in partially checking the infestation. This, however, should be considered as an emergency treatment, and is not recommended as a regular practice. The foliage of peach is too susceptible to injury by oil sprays to justify the recommendation of oil at a strength great enough to give appreciable control of the San Jose scale on peach during the growing season.

OYSTER-SHELL SCALE

The oyster-shell scale (*Lepidosaphes ulmi* L.) (fig. 6), a common pest of apple and pear in the Northern States, winters over in the egg stage underneath the scale covering which protected the mother insect. Hence, to be effective, oil sprays applied during the dormant season must pass through this thick scale covering and then penetrate the shells of the eggs. For complete kill, from 8 to 10 per cent of oil must be used, a strength which allows a rather narrow margin of safety, although it has been used a great many times with no serious injury. Fortunately the oyster-shell scale multiplies at a comparatively slow rate, and the control measures against it do not need to be so completely efficient as is necessary with the San Jose scale in most localities. In the majority of cases the sprays applied for the San Jose scale will incidentally keep the oyster-shell scale from doing serious damage.

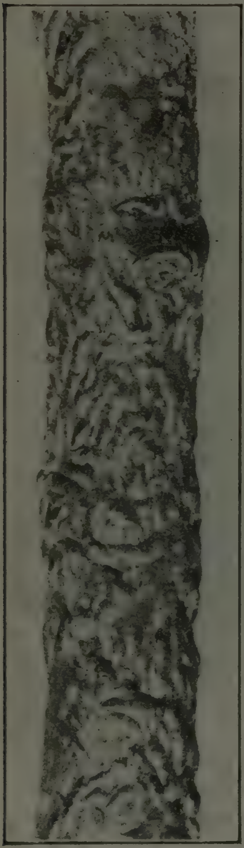


FIGURE 6.—Portion of twig encrusted with the oyster-shell scale. During the winter the scale covering conceals and protects a loose mass of pearly white eggs. About 2½ times natural size

Good results in control have been obtained by summer applications of the white oils at 1½ to 2 per cent. These should be applied 10 days or so after the first crawlers appear (soon after apple trees are in bloom), at which time most of the eggs will have hatched, and the scale coverings over the most advanced individuals will still be thin enough to be readily penetrated by the spray. As already indicated, there is more or less danger of injury to foliage or fruit, particularly if a residue of a sulphur fungicide is present on the trees.

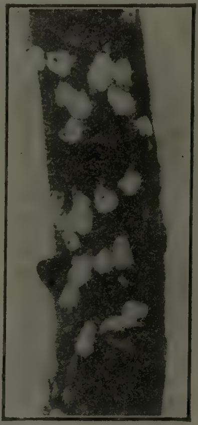


FIGURE 7.—Twig infested with the scurfy scale. The insect winters in the form of purple eggs, underneath the scale covering. Twice natural size

SCURFY SCALE

The scurfy scale (*Chionaspis furfura* Fitch) (fig. 7) is a pest of apple and pear, and is most abundant in the New England and Middle Atlantic States. Like the oyster-shell scale, it winters in the egg stage. During the dormant season the oil sprays seem to penetrate the scale coverings and eggs of this species somewhat more readily than they do those of the oyster-shell scale, and lubricating-oil emulsion at 3 per cent strength has been reported to be effective. In case the scurfy scale is not controlled during the dormant season, the application of summer oils as outlined for the oyster-shell scale may be resorted to as an emergency measure.

TERRAPIN SCALE

The terrapin scale (*Lecanium nigrofasciatum* Pergande) (fig. 8), a pest of peach and plum, is to be found during the dormant season on the under sides of twigs and smaller branches as two-thirds grown females. At this time applications of 4 per cent lubricating-oil emulsion have been found effective.

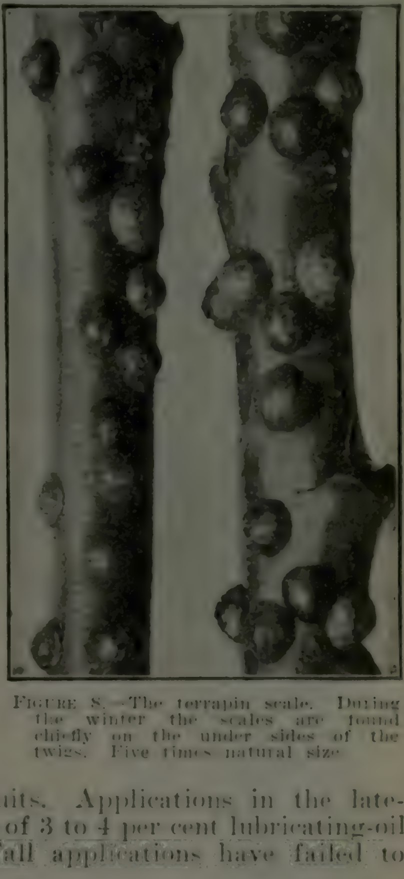


FIGURE 8.—The terrapin scale. During the winter the scales are found chiefly on the under sides of the twigs. Five times natural size

COTTONY PEACH SCALE

The cottony peach scale (*Pulvinaria amygdali* Ckll.) hibernates as nearly mature scales, clustered mostly on the east sides of twigs and smaller branches, and to some extent on the callus growth around old pruning scars and other wounds. Good results have been reported in New York State from dormant applications of 4 per cent lubricating-oil emulsions.

EUROPEAN RED MITE AND CLOVER MITE

The European red mite (*Paratetranychus pilosus* C. and F.) (fig. 9) and the clover mite (*Bryobia pratiosa* Koch) pass the winter in the egg stage, on the twigs and smaller branches of apple, plum, peach, and other fruits. Applications in the late-dormant or delayed-dormant period of 3 to 4 per cent lubricating-oil emulsion have proved effective. Fall applications have failed to give satisfactory control.

If mites become troublesome during the growing season, the infestation may be fairly well controlled by the use of the summer oils at 1 to 2 per cent strength.

FRUIT-TREE LEAF ROLLER

The apple pest known as the fruit-tree leaf roller (*Cacoecia argyrospila* Walker) (fig. 10) is best controlled during the dormant season, when it is present on the trees in the egg stage. The masses of eggs are covered with a hardened gumlike substance, and 7 to 8 per cent of oil in the spray is required to destroy the eggs under this protection.

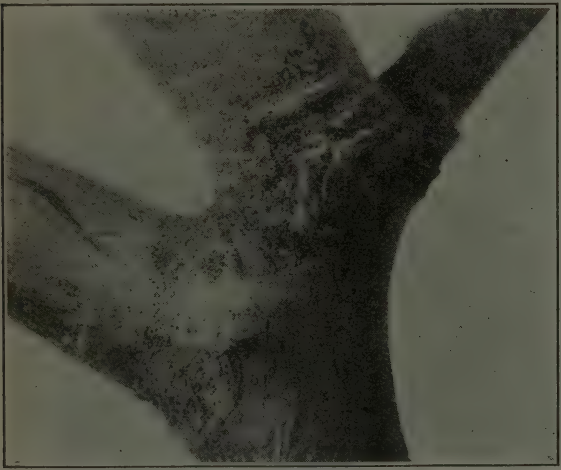


FIGURE 9.—Hibernating eggs of the European red mite. These minute eggs are of a deep red color. About 2½ times natural size

PEAR PSYLLA

The pear psylla (*Psyllia pyricola* Foerst.) (fig. 11), a serious pest in portions of the northeastern part of the United States and in southeastern Canada, hibernates as the adult "fly" in protected situations in and near the orchard, and migrates to the trees with the very first warm days of spring. At this time applications of 3 per cent lubricating-oil emulsion have given very satisfactory results. Many of the adult flies are killed, and the film of oil on the bark appears to have a great deal of residual value, reducing the number of eggs laid, and killing a high percentage of the

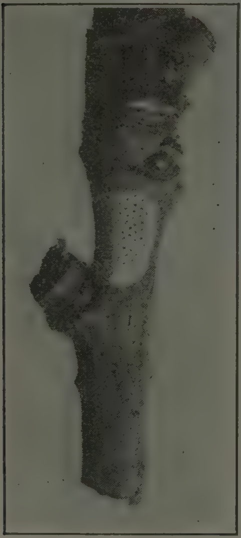


FIGURE 10.—Egg mass of the fruit-tree leaf roller. The eggs in this particular mass have hatched. Twice natural size

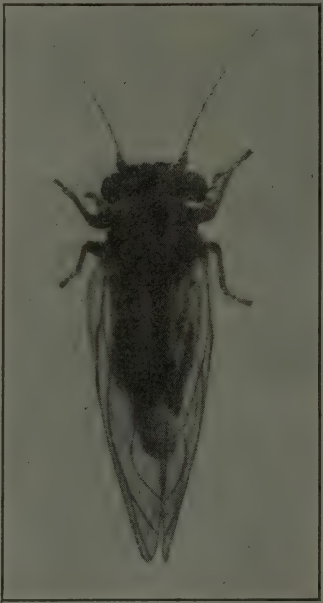


FIGURE 11.—Pear psylla adult (about 20 times natural size). The hibernating adults appear on pear trees on the very first warm days of early spring

young psyllas which hatch. In Ontario the cold-mixed Bordeaux-oil emulsion has proved the most satisfactory, and the heavier oils, those having a viscosity of 150 to 200, seem to be the most effective.

APPLE APHIDS[8]

Most fruit growers are familiar with the shiny black eggs of the apple aphids, as they are found during the winter on the young wood of apple trees. (Fig. 12.) The eggs of these species hatch in early spring, often before the buds have swelled to any extent; the exact time of hatching (with reference to the opening of the buds) varies in different sections, and with the different species of aphids involved. The standard treatment for the combined control of apple aphids and the San Jose scale in sections where both are troublesome has for a number of years been winter-strength lime-sulphur and nicotine sulphate, 1 to 1,000, applied during the so-called delayed-dormant period (figs. 13, 14, and 15), just as the buds are pushing out. This combination has been found very effective in killing the newly hatched aphids, as well as many of the unhatched eggs present.

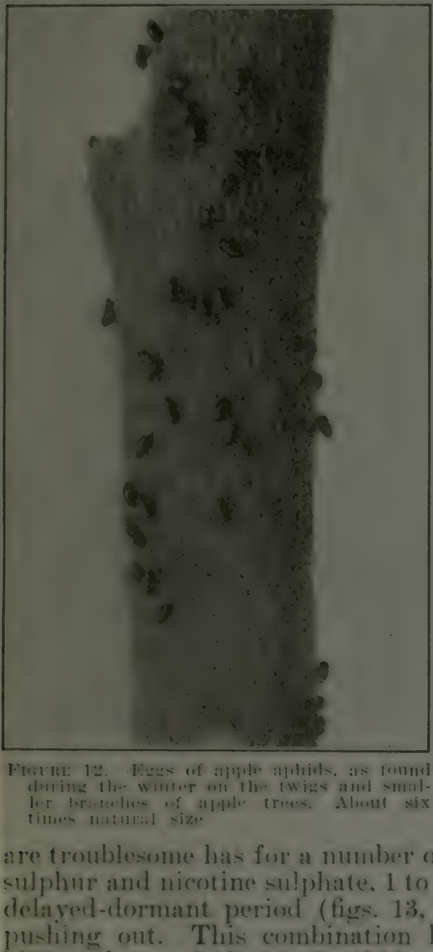


FIGURE 12.—Eggs of apple aphids, as found during the winter on the twigs and smaller branches of apple trees. About six times natural size

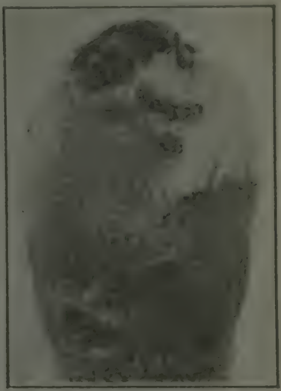


FIGURE 13.—Condition of apple buds in the early part of the delayed-dormant period. The aphids are clustered on the green tips of the buds and have no protection against the spray material

The question often arises whether it is advisable to substitute oil treatments for the lime-sulphur-nicotine mixture in orchards in which aphids must be controlled. This question is of particular importance in orchards in which the presence of the European red mite or the fruit-tree leaf roller dictates the use of an oil spray in preference to lime-sulphur. To have their maximum effectiveness in aphid control, the oil sprays must be applied after the aphids have hatched, since the oils are only partially effective against the unhatched aphid eggs; even when applied after the aphids have hatched, the oils have failed in many instances to give satisfactory control, possibly because of low temperatures at such times, although in other cases good results have been reported.

---

[8] Three species of aphids are involved: The rosy apple aphid (*Anuraphis roseus* Baker), the green apple aphid (*Aphis pomi* DeG.), and the apple-grain aphid (*Rhopalosiphum prunifoliae* Fitch).

Recent experiments in New York State have indicated a high degree of effectiveness in aphid control from a mixture of a 3 per cent lubricating-oil emulsion with 40 per cent nicotine sulphate, 1 pint in 100 gallons, or 50 per cent free nicotine, four-fifths of a pint in 100 gallons, applied during the delayed-dormant period. Further experimental work and commercial experience are needed, however, before this treatment can be recommended for general adoption in sections where the application of oil sprays in the delayed-dormant period appears to be fairly safe.

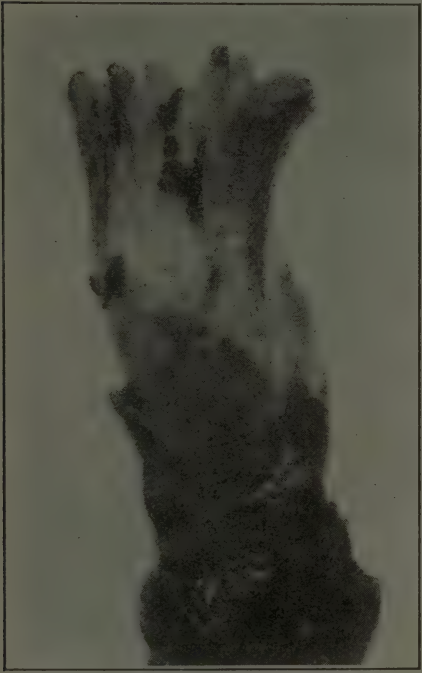


FIGURE 14.—Condition of apple buds late in the delayed-dormant period. Spraying should be completed before the buds advance beyond this stage

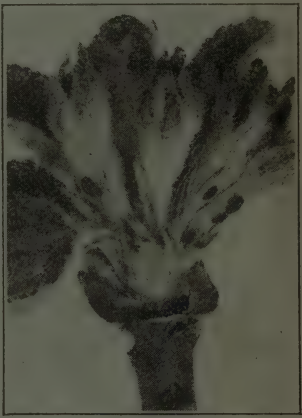


FIGURE 15.—Much too late to make the delayed-dormant application. At this stage of development the leaves and buds may be seriously injured by dormant-strength spray materials, and the aphids find shelter in the crevices between the buds, making it impossible to hit them all

There is always more or less danger of injury during the delayed-dormant period, the danger increasing as the leaves push out and increase in size. In the Northwest the opening buds seem to be especially subject to injury by oil sprays, and in that section it is recommended that the dormant applications of oil be completed before the buds swell to any extent. In other sections of the country the danger of injury seems to be less, although the oil applications should be completed considerably earlier than the stage of development shown in Figure 15.

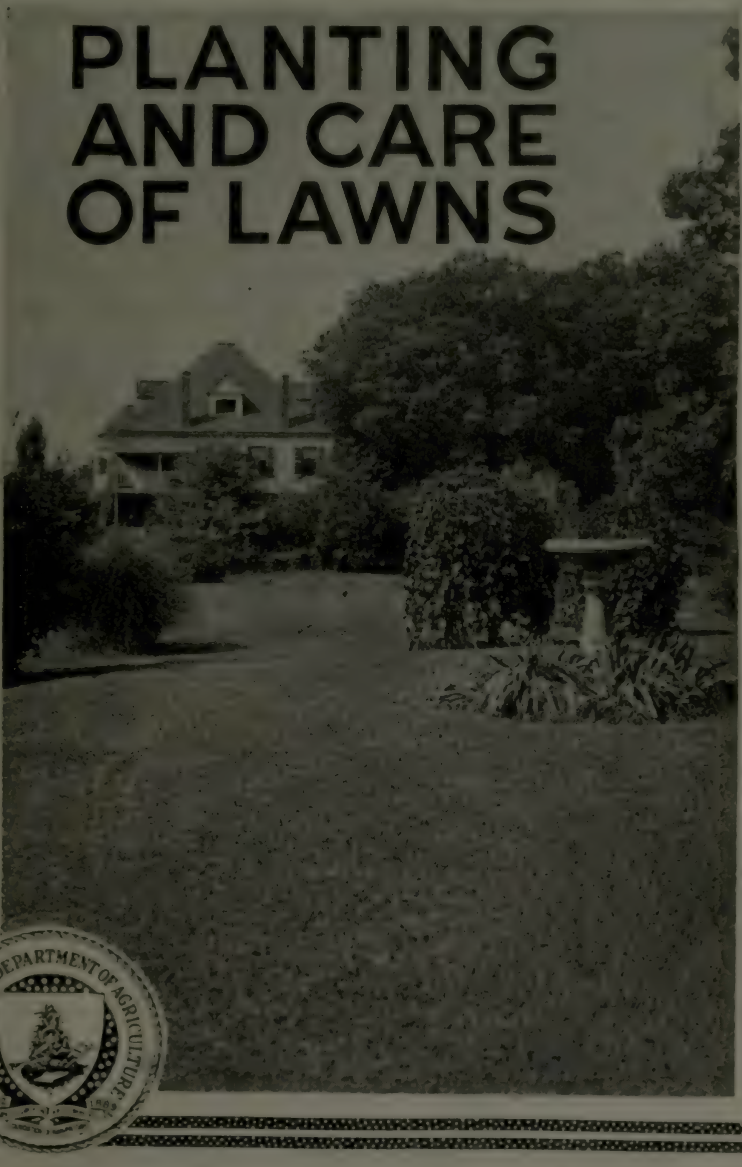
U. S. GOVERNMENT PRINTING OFFICE: 1931

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

U. S. DEPARTMENT OF
AGRICULTURE

FARMERS' BULLETIN No. 1677

PLANTING AND CARE OF LAWNS



1862 1889

LAWN MAKING is relatively simple and does not require an expert. Certain factors, though—physical and climatic—must be observed, and constant care is needed to keep the lawn in good condition.

A properly prepared seed bed and seed of a high standard of purity and germination are two essentials. A good garden loam is the most satisfactory soil. Proper fertilizing is necessary.

There is a wide variation in the soil and climatic requirements of turf grasses. To attain success, the lawn maker should consider these in choosing a type of grass.

Insects and moles damage lawns and must be controlled. Brown-patch disease is controlled by mercury compounds.

Stoloniferous grasses such as Bermuda, centipede, and St. Augustine are more quickly established by the vegetative method of planting than by sowing the seed.

Washington, D. C. **Issued October, 1931**

PLANTING AND CARE OF LAWNS

By H. L. Westover, *Senior Agronomist*, and C. R. Enlow, *Associate Agronomist*,
Division of Forage Crops and Diseases, Bureau of Plant Industry

CONTENTS

Page
Introduction 1
Preparation 1
  Drainage 1
  Grading and leveling 2
  Soils and soil preparation 2
  Preparation and fertilization of seed bed 3
Seed and seeding 3
Vegetative planting 4
Sodding 4
Establishing grass on slopes 5
Lawn grasses 5
Grasses for airports 9
Grasses for polo fields, athletic fields, etc 11
Lawn management 12
  Fertilizing 12
  Top-dressing 13
  Liming 13
  Rolling 13
  Watering 13
  Mowing 15
  Weeds 15
  Removing leaves 17
Renovating old lawns 17
Pests and diseases 17
  Insects 17
  Moles 18
  Diseases 18

INTRODUCTION

A BEAUTIFUL GREEN LAWN is the ambition of most home owners. While many have this desire, few are willing to expend the effort necessary for a successful lawn. The cardinal principles for attaining and maintaining a perfect lawn are relatively simple and do not require the services of an expert, but it is necessary to adhere faithfully to the fundamentals, otherwise inferior lawns are sure to result. Even when these principles are carefully observed the outcome is sometimes disappointing, owing to a peculiar soil or climatic condition. In this bulletin an attempt is made to set forth in simple language practices that have in general resulted in the most satisfactory lawns, with the realization, however, that these suggestions will not meet all requirements. Sometimes the conditions under which a lawn is to be developed are so unusual as to require special treatment. When this becomes necessary, assistance can usually be obtained by writing to the State agricultural experiment station or to the United States Department of Agriculture.

PREPARATION

In starting a new lawn attention must be given to subsurface drainage, grading and leveling the soil, kind of soil, preparation and fertilization of the seed bed, and the use of suitable seed. If any of these features are neglected the results are almost sure to be unsatisfactory.

DRAINAGE

Where the subsoil is so compact that water does not pass through readily, tile draining will prove beneficial. Lines of 4-inch tiles spaced 20 to 30 feet apart, laid 2½ to 3½ feet deep with a fall of from 3 to 4 inches for every 50 feet, should ordinarily insure sufficient underdrainage. The surface should be carefully graded to insure good surface drainage. Water standing in pockets is sure to injure the grass.

605
U5ag
v.74

GRADING AND LEVELING

In grading and leveling, the topsoil, if of good fertility, should be removed and set aside to be replaced after the grading has been completed. Soils on most lawns, however, are inferior to the undisturbed soils of the vicinity, owing to the practice of covering the topsoil with subsoil from excavations mixed with more or less waste materials from building construction. Such soil should be removed to a depth of 4 inches or more and replaced by a good loam or covered to this depth with a good grade of topsoil. Where considerable filling around buildings is necessary, frequently waste materials such as bricks, boards, and pieces of concrete are used in making the fill, as this method is cheaper than to make the entire fill with soil. It is very difficult to maintain the moisture content of such lawns, especially during dry periods. Before seed is sown, this rubbish should be removed to a depth of about 2 feet and replaced with soil. The better quality of turf in years to come will more than justify the added expense involved.

Having given attention to these details, grade the ground so as to furnish surface drainage, though the slope should not be great enough to result in such rapid run-off that the water does not have a chance to penetrate the soil. It is a common practice to construct the lawn so that there is a gradual slope from the house in all directions. This slope should not exceed 1 to 2 per cent. Final leveling is likewise important, as any depressions will interfere with mowing and may hold the water long enough to injure seriously or even kill the grass. Proper leveling is a comparatively simple operation when the lawn is in course of preparation, but after the grass is established the operation is very difficult. Pools of rain water or irrigation water supplied to facilitate the settling of the soil will indicate low places, which should be filled in before the lawn is seeded.

SOILS AND SOIL PREPARATION

While there are grasses that will grow to some extent on poor soils, all of them will thrive better on good soils. Everything considered, what is generally recognized as a good garden loam is about the most satisfactory soil for turf grasses. Unfortunately, not many people have such soil readily available, nor are they always able to purchase it at a reasonable price. It, therefore, becomes necessary to utilize to the best advantage the soil already at hand. Grasses do not ordinarily grow well on heavy clay, and where it is necessary to use such material a quantity of sand equivalent to a surface layer of 1 inch worked into the soil to a depth of 3 to 4 inches will improve the texture very materially. Where the soil is very sandy a similar layer of clay incorporated with the sand will be very beneficial.

Soils from excavations seldom have any organic matter, and this must be supplied in some form if one expects success in maintaining a good lawn. Organic matter not only improves the texture of the soil, especially clay soils, but it also increases the water-holding capacity and improves the drainage. Fine, thoroughly decomposed stable manure or mushroom soil can be used to supply organic matter. This should be thoroughly mixed with the soil, one-half ton to 1,000 square feet usually being sufficient. Where neither of these is available some of the granulated peats will be found helpful. One should be careful, however, in the use of peats, as some of them are toxic to most plant life. In case of large lawns it is sometimes necessary to resort to the use of a green-manure crop, preferably a legume. In this way organic matter can be supplied by turning under the crop, but on the average lawn, manure or mushroom soil is more satisfactory.

PREPARATION AND FERTILIZATION OF SEED BED

The final preparation of the seed bed should start two or three weeks in advance of the most favorable time for sowing. The end results will fully justify great care in putting the seed bed in the best possible condition. An ideal seed bed is one that is firm but has a very finely pulverized surface. Thorough watering in advance of sowing is necessary to settle the soil and to give proper moisture to insure subsequent germination of many weed seeds that might later prove troublesome. The soil should be stirred occasionally with a garden rake or some other implement to destroy the weeds that have started.

A few days before sowing the seed a liberal application of fertilizer containing the three most generally needed plant-food elements—nitrogen, phosphorus, and potassium—is advisable. This may not be necessary provided a liberal application of well-rotted barnyard manure has been worked into the soil during grading and leveling. Even when manure has been used, however, some readily available fertilizer will insure an early, vigorous growth of grass. Organic fertilizers such as bone meal, cottonseed meal, sewage sludge, and poultry manure have been used with excellent results. These should be applied at the rate of 20 to 25 pounds per 1,000 square feet and thoroughly worked into the soil. Cottonseed meal and sewage sludge mixed with ammonium sulphate in the proportion of 3 parts of either the meal or sludge to 1 of the sulphate will be found to give somewhat quicker results. The mixture may be applied at the rate of 12 or 15 pounds per 1,000 square feet. Where these materials are not available or where the prices are out of proportion to the plant-food content, a complete fertilizer high in nitrogen, such as 6–8–4, can be applied at the rate of 25 to 30 pounds per 1,000 square feet. The fertilizer should be evenly distributed and raked into the soil a few days before the seed is sown.

SEED AND SEEDING

Lawns started with seed require all possible care to insure a good, thick stand of grass. Two essentials are a properly prepared seed bed and use of seed of a high standard of purity and germination. To attempt to reduce the cost of starting a lawn by economizing on seed is a poor policy. As a rule, city lawns are not large, and the difference in cost between light and heavy seeding is not great. A thick stand from the beginning is not only highly desirable but almost essential to assist in holding the weeds in check.

In the northern half of the United States the lawn should be started in the fall when weeds are less troublesome. Spring sowings are likely to be crowded out by weeds. Southern and less hardy grasses usually succeed best when sown in the spring. Fall sowings should be made early enough to enable the grass to become well rooted before freezing weather, as it will then be in condition to start growth early in the spring and compete more successfully with the weeds.

It is regrettable that many home owners do not take much interest in starting a lawn in the fall. It is only after outdoor activities have been suspended for some time that the desire to work in the soil returns. Because of this many lawns are started in the spring, and a high percentage of failure results. Weed competition is especially great at this time and, furthermore, hot weather is likely to occur before the seedlings are well enough established to withstand such a severe test. Where spring sowings become necessary, the operation should take place as early as the ground can be worked. In fact, in the latitude of Washington, D. C., seed has been sown on bare ground in midwinter with fair results.

From 3 to 5 pounds of seed per 1,000 square feet is recommended, depending upon the size of the seed. If the seeds are large, the rate of sowing should be increased. In order to insure even distribution it is a good practice to divide the seed and broadcast one-half each way of the lawn. After sowing, the ground should be raked lightly and rolled and sprinkled later if the soil becomes dry. The surface of the ground should not be allowed to become dry until the seedlings are well rooted.

VEGETATIVE PLANTING

During the last few years there has been considerable interest in vegetative plantings due primarily to the wide use of this method of establishing creeping bent putting greens on golf courses. (Fig. 1.) The method has long been utilized in the case of Bermuda grass, and more recently in starting lawns with centipede and St. Augustine grass. In the case of stoloniferous grasses like those mentioned above, a good turf may be established in less time by the vegetative method of planting than with seed. Centipede grass and some strains of creeping bent are planted vegetatively only as no seed is commercially available. One method is to chop the runners into pieces an inch or so in length, broadcast these over the lawn, roll, then cover with a thin layer of soil or compost, and water immediately. The surface must not be allowed to become dry until the pieces of runners have rooted and started to grow. One or two pounds of stolons, or in the case of creeping bent 1 square foot, is enough for 10 square feet of lawn. Another method is to set plants or pieces of stolons 2 to 3 inches long in rows 8 inches apart with pieces 4 to 6 inches apart in the row. Spacing can be increased or decreased according to the amount of planting material at hand. Close spacing will naturally give a good sod in less time. Whichever method is used, it is essential that the material be kept moist both before and after planting. Unless unusual care is given to bentgrass lawns planted vegetatively, the results are sure to prove disappointing.

SODDING

One of the quickest ways to establish a lawn is by the use of sod, though it is usually difficult to obtain a good quality. The chief objection is the expense involved. In sodding, the soil should be prepared as for sowing seed, except that it should be somewhat more compact. Experience has shown that sods cut 1 inch thick are most convenient to lay, and that in sods of this thickness new roots develop so that it becomes thoroughly established sooner than where the sod is thicker. To insure a level lawn the sod must be of uniform thickness and cut in true squares which will fit together perfectly.

ESTABLISHING GRASS ON SLOPES

Establishing grass on steep slopes is by no means easy. In fact, where the slope is very steep it is often impossible to maintain turf, and it is then necessary to resort to the use of some plant like Japanese honeysuckle or English ivy. Where the slope is not too steep, however, and where other conditions are not unfavorable, grass can be established if special attention is given to prevent washing and to keep the soil sufficiently moist for the seedlings. One of the best methods where seed is used is to cover the newly sown slope with loosely woven burlap tightly drawn and staked to hold it in place. Old burlap bags ripped apart are excellent for this purpose. The covering of burlap retains the moisture and prevents erosion or washing. The grass will come up through the meshes of the burlap, which need not be removed, as it soon decays. Everything considered, the most satisfactory method is to sod the slopes, though the cost, of course, is somewhat greater than that of seeding. Whether sodding or seeding is employed, special attention must be given to watering, as slopes dry out rapidly.

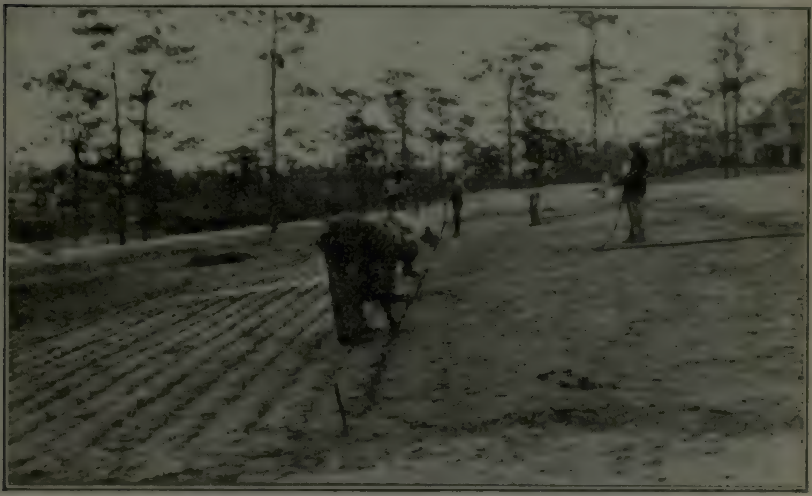


FIGURE 1. Starting a centipede-grass lawn by vegetative plantings. St. Augustine, carpet, Bermuda, and the creeping bents are frequently started in this way also

LAWN GRASSES

There is a wide variation in the turf grasses that succeed best under different soil and climatic conditions. It is impossible to suggest individual grasses or grass mixtures that will meet all requirements. On the basis of many years of practical as well as experimental results, recommendations are made for turf grasses in various parts of the United States, as shown on the accompanying map. (Fig. 2.)

REGION 1

In region 1 (fig. 2), where conditions are favorable, Kentucky bluegrass has no superior for general use, as it has a strong root system and will stand much rough treatment. On soil well supplied with lime, organic matter, and plant food, Kentucky bluegrass can be sown alone with good results, though because of the fact that it starts off rather slowly, a small amount of redtop usually is sown with it. (Fig. 3.)

Where the soil is acid the bentgrasses, including colonial bent, seaside bent, South German mixed bent, and creeping bent, grow much better than Kentucky bluegrass. (Fig. 4.) In fact, the bents do well where Kentucky bluegrass is not able to survive and where there is little use of sowing grasses other than those tolerant to acid conditions. Soils especially suited to such grasses are quite usual in parts of New York and the New England States and along the Pacific coast of Oregon, Washington, and northern California. Seed of all these grasses is available with the exception of the creeping bent, which is the grass commonly used on golf greens. This grass is started vegetatively by planting pieces of runners or stolons. Due to the fact that putting greens established with creeping bent make such a beautiful appearance, home owners frequently wish to use it on the lawn. Creeping bent can of course be grown on the lawn as well as on the putting green, but it requires much attention in the way of watering, fertilizing, top-dressing, and treatment to control the brown-patch disease. Unless prepared to give the grass this extra attention, one is more likely to succeed with the ordinary lawn grasses.

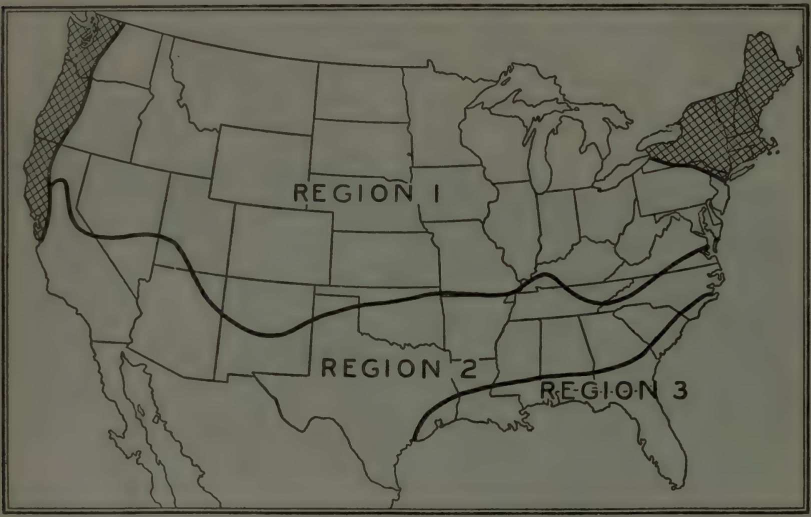


FIGURE 2.—Map showing regions of the United States to which the various lawn grasses discussed in this bulletin are adapted. Crosshatched areas in region 1 represent those areas in which the bentgrasses are most likely to succeed

FIGURE 3.—Kentucky bluegrass. For a large part of region 1 this has no equal as a lawn grass

FIGURE 4.—A lawn of bentgrass. The bentgrasses make beautiful lawns in the Pacific Northwest and in New England when given the necessary attention

Like bentgrasses, the fescues, including red and Chewings fescue, are acid tolerant and suited to soil conditions similar to those favorable to bentgrasses. They do not, however, survive well under close cutting except where the summers are cool. These grasses are among the best for shady conditions.

For various reasons, it is usually safer to sow a mixture of grasses than to depend on one grass. For the greater part of region 1 the following mixture has proved quite satisfactory: Kentucky bluegrass 17 parts, redtop 2 parts, white clover 1 part by weight. In the eastern part of this region where conditions are less favorable for Kentucky bluegrass, the following more general mixture has given good results: Kentucky bluegrass 10 parts, Chewings fescue 5 parts, redtop 2 parts, colonial bent 1 part, white clover 1 part by weight.

In this region fall sowing is decidedly preferable to spring sowing. Where the seed is sown in the spring, it is usually advisable to add about 10 per cent Italian ryegrass to the mixture, reducing the amount of Kentucky bluegrass proportionately.

It is usually very difficult to maintain good turf under shade. In fact, it is almost impossible where the shade is very dense. Under such conditions it may be necessary to reseed each year. In the North, *Poa trivialis* is in general the most satisfactory grass, particularly in the shade of buildings. Under trees, especially where the soil is sandy, European red fescue or Chewings fescue will often thrive where other grasses fail. Much of the difficulty in growing grasses in the shade is due to the failure to recognize the need for more attention to watering and fertilizing, as a result of the demands of the trees.

REGION 2

The grass generally best suited to region 2 is Bermuda (fig. 5), although at the higher altitudes in the piedmont or under partially shaded conditions Kentucky bluegrass does very well. Bermuda grass may be started by sowing seed or by planting pieces of the stolons in the spring after the ground has warmed up thoroughly, or in the early fall. In the western part of this region the bents and Kentucky bluegrass usually do fairly well under irrigation, provided Bermuda grass can be kept from invading the lawn, which is no easy problem. In the humid part of region 2, where a legume is desired, Carolina clover, lespedeza, and white clover may be sown with the Bermuda grass. At the higher altitudes, Kentucky bluegrass may replace Bermuda grass.

The chief objection to Bermuda grass is the fact that it dies down in the winter and much of the beauty of the lawn is lost. To overcome this condition the Bermuda-grass lawn is "scalped," or mowed closely, in the fall, the soil loosened with a rake, and sown to Italian ryegrass. It is well to top-dress lightly with compost after sowing the grass seed. The ryegrass comes up quickly and continues to grow throughout the winter but dies down in the spring about the time the Bermuda grass starts growth.

In the northern part of this region Kentucky bluegrass usually succeeds well in the shade, provided the shade is not too dense. In the southern part none of the common grasses are particularly adapted to such a purpose. Under sufficiently mild conditions, St.

Augustine grass is one of the best shade grasses when sufficient moisture and plant food are supplied.

REGION 3

Most of the lawns in region 3 are started with a single grass rather than with a mixture. As the grasses suited are rather susceptible to cold they should be started in the spring after the ground warms up thoroughly. Carpet grass is especially desirable on moist soils. Seed is commercially available, though many lawns are started by setting out pieces of the plant. When seed is used, 3 to 5 pounds per 1,000 square feet is advised.

Bermuda grass can be used for the drier areas, especially where the soil is of heavy texture. Suggestions for starting a Bermuda-grass lawn and for sowing to Italian ryegrass for a winter lawn are discussed under region 2.

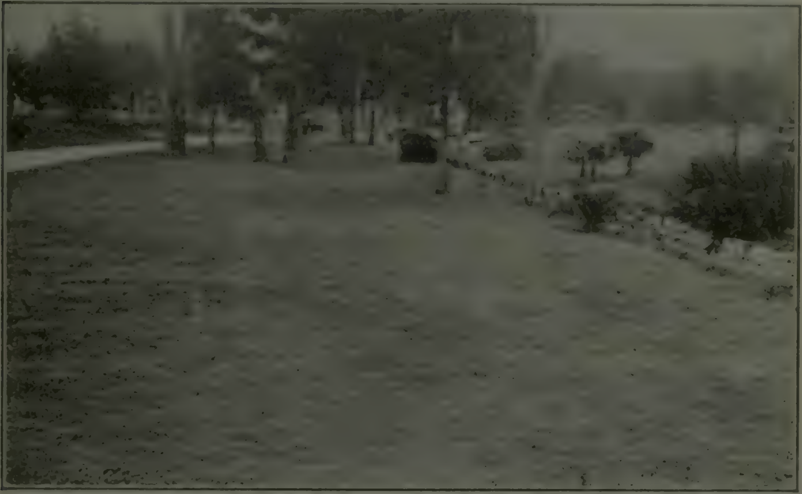


FIGURE 5.—Bermuda grass. This grass is particularly adapted to the heavy soils of region 2

Centipede grass (fig. 6) is rapidly becoming one of the outstanding lawn grasses in region 3. It is one of the best lawn grasses where the winters are mild, and will grow on any except poorly drained soils. As seed is not commercially available, all such lawns have to be started vegetatively.

St. Augustine grass (fig. 7) has no equal in Florida and the coastal plain of the Southern States as a shade grass. It grows equally well in the sun. If given plenty of water and nitrogen fertilizer, it will grow under practically all conditions in this section. It is one of the best grasses available for shady places; but, since seed is not available, lawns are started vegetatively.

GRASSES FOR AIRPORTS

Commercial flying is a rather recent development in the United States, and actual experience with grasses for airports is rather limited. Valuable suggestions may usually be obtained by studying the grasses that seem to thrive best in old meadows and pastures in

FIGURE 6.—Centipede grass. In region 3 this is rapidly becoming one of the outstanding lawn grasses

FIGURE 7.—St. Augustine grass. As a shade grass, St. Augustine has no equal in Florida and the coastal plain of the Southern States

the vicinity of the airport site. The results of investigations with turf grasses for lawns, golf courses, etc., furnish a useful source of information, though it is realized that airports usually are of considerable area and the methods used in establishing and maintaining turf on lawns and golf courses are too expensive for use on airports and are not warranted, since a turf of such fine quality is not essential. The main requirement is a turf that will stand up under rough usage. For this reason some of the coarser and tougher grasses should be included in the mixture. Experience indicates that no grass is likely to survive on the runways of airports where the traffic is heavy. For these areas it is likely that some material such as concrete or cinders will prove more satisfactory, and that no difficulty will be encountered in maintaining a turf on the remainder of the field that is used only in case of emergency.

In region 1 (fig. 2), where the moisture conditions are favorable and the soil is not acid, or only slightly so, and is well supplied with organic matter, where it is well drained, of a medium to heavy texture, and in a good state of fertility, Kentucky bluegrass has no superior and should constitute a considerable portion of any mixture. Under such conditions a mixture composed by weight of 3 parts Kentucky bluegrass, 1 part redtop, 1 part Italian or perennial rye, 1 part timothy, and one-half part white clover is suggested. Where the soil is acid and low in fertility there is little use in sowing Kentucky bluegrass. Under such circumstances a mixture composed by weight of 2 parts redtop, 2 parts red or Chewings fescue, 1 part timothy, 1 part meadow fescue, and 1 part of Italian or perennial ryegrass may be used. Of course, where the soil is low in fertility, none of these grasses can be expected to make satisfactory growth without the addition of fertilizer. For sandy areas that are inclined to be dry at times, a mixture composed by weight of 3 parts red fescue or Chewings fescue, 3 parts Canada bluegrass, 1 part redtop, 1 part timothy, and 1 part meadow fescue is advised. In the northern Great Plains, where the moisture is not sufficient for Kentucky bluegrass, crested wheatgrass, western wheatgrass, and smooth bromegrass may be used. If it is too dry for these grasses none of those of which seed is commercially available can be expected to succeed. Under such conditions the native sod makes the best turf for an airport, but when this has once been destroyed it is almost impossible to restore it.

For region 2 (fig. 2), Bermuda grass is in general the most suitable grass for airports.

For region 3 (fig. 2), the grasses suggested for different soil conditions for lawns are best suited to similar conditions for airports.

GRASSES FOR POLO FIELDS, ATHLETIC FIELDS, ETC.

The grasses that have given the best results on lawns in the various regions described in this bulletin are also likely to prove most satisfactory for polo fields, athletic fields, bowling greens, lawn-tennis courts, etc. Recommendations for preparing, seeding, and care as given for the lawn apply equally well here. Because of the size of polo and athletic fields it may not be practicable to give them as much attention along cultural lines as is given the lawn, or as tennis courts and bowling greens require.

LAWN MANAGEMENT

After proper attention has been given to starting a lawn, the care that it receives has much to do with its success. In most parts of the country constant attention is necessary to maintain a good lawn.

FERTILIZING

Proper fertilizing is essential to the development and maintenance of a satisfactory turf, but unfortunately this feature is often sadly neglected. As most city lawns are relatively small, the cost of proper fertilizing is not great. One of the first requirements is a liberal supply of available nitrogen. Grasses do not demand so much phosphorus and potash, and since these elements are less soluble than nitrogen they are often present in the soil in sufficient quantities, though to avoid the possibility of a deficiency a fertilizer containing some phosphorus and potash should be applied occasionally. A fertilizer that has given satisfactory results and one that is easily applied is a mixture consisting of 3 parts cottonseed meal and 1 part sulphate of ammonia. Where the cost of cottonseed meal is prohibitive or where it is not available, sewage sludge may be substituted for it. Where neither can be obtained a complete fertilizer high in nitrogen such as 6—8—4 may be used. Any of these should be applied at the rate of 15 to 20 pounds to 1,000 square feet. Experience indicates that the most liberal application of such fertilizers should be made early in the spring, as soon as the danger of hard freezes is over, as such application encourages a vigorous growth of grass that tends to hold the weeds in check. An early fall application of 10 to 15 pounds to 1,000 square feet is also desirable. If the grass shows evidence of lack of vigor in late spring or during the summer, a light application of some quick-acting fertilizer can be made. For this purpose there is nothing superior to sulphate of ammonia or nitrate of soda, but unless applied carefully they are liable to burn the grass. Using 3 pounds of either to 1,000 square feet is sufficient for one application. It is suggested that they be applied in mixture with good compost consisting of 3 parts of loam and 1 part of finely divided manure or mushroom soil spread evenly over the surface. After the mixture is applied it should be watered thoroughly. Bone meal is extensively used as a fertilizer on established lawns, though it is not particularly desirable for this purpose since it is low in nitrogen and the plant-food elements are slowly available. When used it should be applied in the late fall at the rate of 20 25 to 25 30 pounds to 1,000 square feet.

Fine well-rotted manure or mushroom soil applied in the late fall or early winter is beneficial when comparatively free from weed seeds and evenly distributed. It should be sifted or otherwise finely divided, as coarse manure may prove detrimental. High-grade pulverized poultry manure is also quite effective and where available at a reasonable cost can be used advantageously. It should be applied at the rate of 15 20 or 20 25 pounds to 1,000 square feet, preferably in the early fall. There are many special brands of lawn fertilizers on the market. While usually effective, they are likely to contain more phosphorus and potash in proportion to nitrogen than the grass requires when applied as surface applications to established lawns; their cost, too, is generally more than the fertlizing ingredients purchased separately.

CORRECTIONS FOR FARMERS' BULLETIN 1677, PLANTING AND CARE OF LAWNS, EDITION OF 1931

Page 12, last line of second paragraph should read: " rate of 25 to 30 pounds to 1,000 square feet."

Page 12, seventh line of last paragraph should read: " at the rate of 20 or 25 pounds ", etc.

Page 15, last sentence in second paragraph should read: " The mower should be set to cut at a height of at least 1 inch and preferably more during midsummer."

Page 15, next to last paragraph, the following should be substituted for the last two sentences: " Considerable success in crabgrass control has been attained by practicing high cutting and limited watering from late May to September 1. If the mower is set to cut 2 inches high during this period the heavy growth of lawn grass smothers most of the crabgrass seedlings, and infrequent watering prevents normal development of those plants that survive."

11280—33

U. S. GOVERNMENT PRINTING OFFICE: 1933

WATERING

To maintain a vigorous growth of grass, watering is necessary. (Figs. 8 and 9.) Wherever possible, a permanent watering system should be installed before the lawn is seeded. Such a system is very market. While usually effective, they are likely to contain more phosphorus and potash in proportion to nitrogen than the grass requires when applied as surface applications to established lawns; their cost, too, is generally more than the fertlizing ingredients purchased separately.

TOP-DRESSING

Most grasses are benefited by an occasional top-dressing with a good compost consisting of about equal parts of manure, sand, and heavy-textured topsoil, as a clay loam. Mushroom soil or a good grade of garden loam is also suitable for this purpose. If the lawn soil consists largely of clay, the top-dressing should contain a higher percentage of sand; if very sandy, it should contain proportionately more clay. The top-dressing should be applied to a depth of one-fourth to three-eighths inch about every two years in the fall. Where the lawn has small pockets and bare places as a result of heaving during the winter and early spring, top-dressing will improve the condition very materially.

LIMING

Probably no one factor in lawn maintenance has been the cause of more general discussion or has been so widely abused as the use of lime. Not many years ago heavy annual applications of lime were the usual thing. More recently, experiments indicated that certain grasses do better on acid soils; and since general observations indicated that weeds were less troublesome under such conditions, the pendulum swung to the other extreme, and efforts were made to produce extremely acid conditions in the soil in the shortest time possible. Further investigations indicate, as is so often the case, that, everything considered, a course midway between these two extremes is safest and that a soil about neutral in reaction is likely to give the best results. Where soil is known to be acid, or sour, lime should be worked into it before the seed is sown. It is not possible to make a specific recommendation as to the amount, since requirements of different soils vary so widely. In the case of soils of average acidity, 40 to 50 pounds per 1,000 square feet should be ample. In most cases lime used as a top-dressing has not been very effective. Under the impression that it is a fertilizer, many persons make annual applications of lime without adding any plant food. Lime is not a fertilizer, as many seem to think; and even where it is used, the usual application of fertilizer should be made. Additions of lime alone, instead of improving the soil, are often harmful, as it merely encourages the weeds without benefiting the grass. If the grass is not making satisfactory growth after proper fertilizing, however, and if an examination shows the soil to be acid, an application of lime may be beneficial.

ROLLING

The freezing and thawing that take place during the winter months in most of the United States tend to push the grass out of the soil. Rolling early in the spring, while the soil is not too moist, with a 300 or 400 pound roller presses the plants back into position where they are able to grow to best advantage. Frequent rolling is not recommended for smoothing lawns, as it may puddle the soil. Smoothing is accomplished more readily by top-dressing.

WATERING

To maintain a vigorous growth of grass, watering is necessary. (Figs. 8 and 9.) Wherever possible, a permanent watering system should be installed before the lawn is seeded. Such a system is very convenient and saves hours with the garden hose. Rarely is a lawn overwatered. During hot, dry weather the lawn should be watered frequently and thoroughly. The usual practice of sprinkling lightly each day is very objectionable. A thorough soaking encourages deep-root development, while the light sprinkling stimulates surface roots; and when watering is neglected the grass suffers. Furthermore, the deeper root system furnishes more area from which the plant can draw its nourishment. The lawn may be watered at any time of the day or night, though there is less loss from evapo-

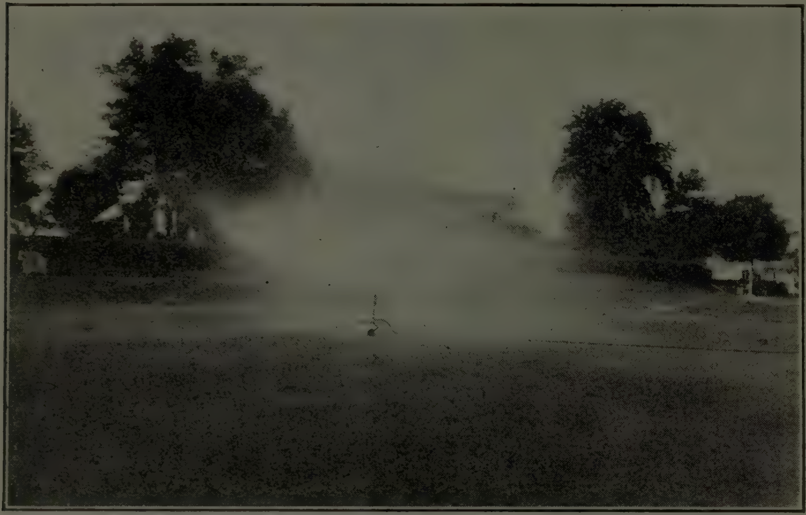


FIGURE 8.—Type of sprinkler advisable for large lawns

FIGURE 9.—Lawn watered by a permanent watering system. Such a system saves hours with the garden hose

ration when watered in the evening, which is also the most convenient time for most home owners. Where the lawn contains bents and fescues, however, early morning watering is preferred, as evening watering makes conditions more favorable for the brown-patch diseases. Grass beneath or near trees requires more water than that in the open; likewise, south and west exposures subjected to the direct rays of the sun require more moisture than less exposed areas. Slopes demand special attention on account of the rapid run-off.

MOWING

A newly sown lawn should be cut when the grass is 2 or 3 inches high. Not only is a lawn much more attractive when properly mowed, but sod-forming grasses are benefited by such treatment while some weeds are killed and the growth of others is checked. The grass should not be cut extremely close. Very close cutting, when the lawn is not mowed frequently, will injure the grass by sudden exposure to the sun after it has been shaded by the dense growth. The mower should be set to cut at a height of three-fourths of an inch to 1 inch.

No definite rule can be given regarding frequency of mowing, as everything depends upon the type of grass, the amount of fertilizer applied, the frequency of watering, weather conditions, etc. There is little danger of cutting too frequently. Clippings from the mower should be removed, as when left they tend to encourage diseases. If the lawn is fertilized and top-dressed properly the plant food lost by removal of the clippings will not be noticeable. The clippings make excellent compost when mixed with soil and left until thoroughly decomposed. However, in some instances where the growth is fine as a result of frequent cutting, the turf seems to be benefited by allowing the clippings to remain.

WEEDS

Weeds present one of the most difficult problems in lawn maintenance. (Fig. 10.) The amount of labor involved in keeping weeds out of a lawn may be reduced by making the conditions so nearly ideal for the lawn grass that it is always growing vigorously, thus tending to hold the weeds in check.

The most troublesome weeds are crabgrass, dandelions, plantain, and chickweed. Generally speaking, crabgrass is the worst pest that the lawnkeeper has to combat. It starts to grow after the weather is warm and continues to spread vigorously until the first frost occurs in the fall. Many people express surprise at the sudden dying out of what they considered was a very beautiful lawn, not realizing that the crabgrass, which is an annual, had invaded the lawn and smothered out the grasses that survive from year to year, thus leaving a brown unsightly lawn during the winter and necessitating reseeding. Unfortunately, the only known effective way of eradicating this pest is hand weeding. Home owners should familiarize themselves with its appearance when it is young, as it is more easily eradicated at that time. Often, however, crabgrass appears in such abundance as to render hand weeding out of the question.

In some sections dandelions become a serious pest in the lawn. The only sure method of eradicating them is hand weeding. The individual plants should be cut 2 to 3 inches below the surface of the ground with a spud, an asparagus knife, or some similar tool. Shallow cutting is worse than useless, since new tops spring up quickly from the cut surface.

Plantain also becomes a pest in certain sections, and, as is the case with dandelions, hand weeding is the only effective remedy. The practice, unfortunately quite common, of liming the lawn heavily each spring without fertilizing favors the growth of dandelions and plantain.

Chickweed often appears in patches in the lawn. As a rule it is no great problem to cut out such patches. Where this is impracticable the weed usually can be destroyed by dusting the patches with what ammonium sulphate will adhere to the leaves, preferably when the leaves are wet from dew or as a result of sprinkling, leaving it for a day, and then watering thoroughly. This will usually kill the chickweed, and while it may burn the grass, no permanent injury is likely to result.

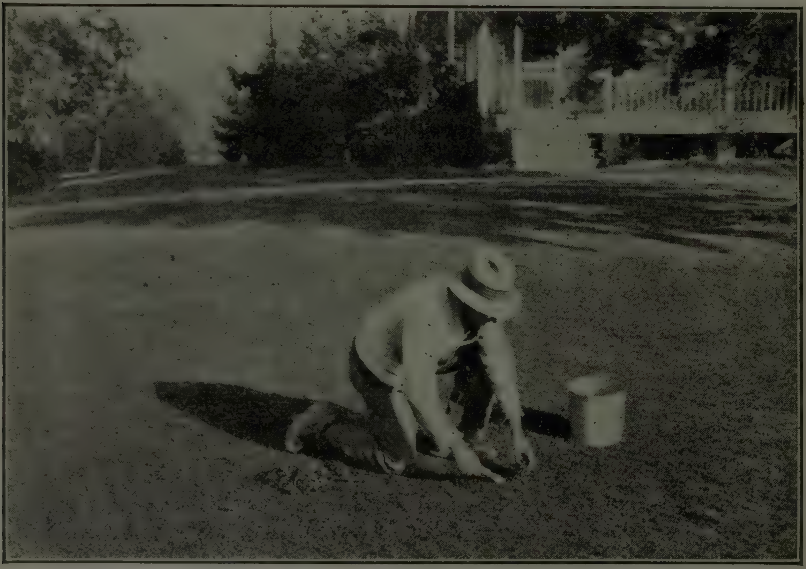


FIGURE 10.—Removing weeds from the lawn. Cut the roots as far as possible below the surface with a knife or spud

Moss is sometimes troublesome on lawns. Usually its presence indicates an impoverished condition of the soil, poor drainage, or too much shade. Moss does not necessarily indicate an acid soil, as it grows where lime has been used abundantly. Where moss occurs scattered in small patches and where there is a uniform but weakly growth of grass, liberal fertilizing will usually increase the vigor of the grass so that the moss will gradually be crowded out. Sprinkling patches of moss liberally with ammonium sulphate, as described in the case of chickweed, is sometimes an effective means of destroying it. Large patches can be raked out and the bare areas reseeded.

The use of chemicals, thus far, has not proved a very effective means of controlling most lawn weeds. The reliable method of clearing the lawn of weeds is to keep after them continually. Cut the root of the plant as far as possible below the surface with a knife or spud.

REMOVING LEAVES

Leaves from trees should be removed from the lawn, as they are likely to injure the grass by smothering it, especially when the layer is thick enough to hide the grass. Leaves contain very little available plant food and are practically worthless as a fertilizer unless composted until completely decayed. There is a rather general though erroneous belief that the grass is benefited by the protective covering furnished by leaves.

Grasses recommended for the different regions seldom require protection during the winter and are likely to be injured by the smothering and shading effects of leaves.

RENOVATING OLD LAWNS

When a lawn becomes thin and sickly looking, the question arises as to whether it is advisable to spade it up and start all over or to try to develop a satisfactory turf without disturbing the grass that is present. As a rule, it will be more satisfactory to start a new lawn. However, where there is a fairly even distribution of grass, it is usually possible to develop a good turf by giving proper attention to fertilizing, top-dressing, mowing, and watering. Such lawns should be first liberally fertilized in accordance with the suggestions given on page 12 and then top-dressed with one-fourth to three-eighths of an inch of a rich, garden loam or compost made with equal parts of topsoil, sand, and manure. Where there are many large bare patches in the lawn, it is better to spade the ground and start over, as it is difficult to produce a satisfactory lawn by reseeding bare areas.

PESTS AND DISEASES

INSECTS

Earthworms, grubs, and ants are the insects most generally infesting lawns. In the Southeast mole crickets sometimes become quite a pest. Grubs and earthworms have been successfully controlled by the use of arsenate of lead. An application of 5 pounds of this material thoroughly mixed with a bushel of moist soil or sand should be spread uniformly over 1,000 square feet of lawn. It may be necessary to repeat the application every year or two. It is advisable to water the lawn well after applying lead arsenate, in order to lessen the danger of poisoning chickens or other animals that might eat some of the grass.

Corrosive sublimate is very effective in ridding the soil of earthworms—2 or 3 ounces dissolved in 50 gallons of water is sufficient for 1,000 square feet of lawn. After the solution is applied it should be watered in thoroughly. Corrosive sublimate may also be applied dry by mixing 2 or 3 ounces with 2 cubic feet of dry sand and scattering the mixture uniformly over 1,000 square feet of lawn. Liberal watering should follow. Unless these instructions are carefully followed, serious burning of the grass is sure to result. It should be remembered that corrosive sublimate is a deadly poison.

Ants sometimes become quite a problem on the lawn, and while no entirely satisfactory means of control has been discovered, good

JUN 17 32
SEP 21 '32

results have been obtained by injecting carbon disulphide into the nests by means of an oil can with a long spout or a syringe, the quantity varying from one-half to 2 or 3 ounces, depending upon the size of the nest. The entrance to the nest should then be closed. Carbon disulphide should be kept away from fire as its fumes are highly inflammable.

Mole crickets sometimes become very troublesome in the Southeastern States and do considerable damage by tunneling just beneath the surface of the ground. No entirely effective method for the control of these pests when they are working in lawns or turf has been developed. A poisoned bait has been used with considerable success under certain conditions against the Porto Rican mole cricket and in some cases might be used to advantage on lawns. The method of preparing and applying the bait is discussed in Farmers' Bulletin 1561, The Porto Rican Mole Cricket. Carbon-disulphide emulsion can be used, but that treatment is rather expensive, as the emulsion is applied at the rate of about one-half gallon to each square foot of grass. The emulsion should be thoroughly watered in, so that it will penetrate the burrows of the mole crickets. Liberal watering will also prevent injury to the grass. Directions for the preparation and application of carbon-disulphide emulsion can be obtained by writing to the Bureau of Entomology.

MOLES

Moles frequently tunnel in lawns in their search for food, leaving unsightly ridges over their runways. It is not uncommon for the grasses to turn brown over the tunnels, as the result of the cutting of the grass roots by the moles and the drying out of the soil.

Moles are not easy to control. Trapping has proved to be one of the dependable methods of destroying them. This and other control methods are discussed in Farmers' Bulletin 1247.

Materials with properties repellant to moles are often used successfully in driving them from a lawn. The runways should be opened with a stick at intervals of 10 to 15 feet and a teaspoonful of flake naphtha, moth balls, paradichlorobenzene, or lye inserted, after which the holes should be carefully closed with soil. Moles may be drowned occasionally by inserting the garden hose in the runways and flooding them.

DISEASES

The most serious diseases of turf grasses are what are known as large and small brown patch, which attack the bentgrasses, the fescues, redtop, and ryegrass. These diseases are most effectively controlled by the use of mercury compounds. Two ounces of calomel and 1 ounce of corrosive sublimate mixed with soil or sand applied to each 1,000 square feet of lawn will check the spread of these diseases. The lawn should be watered thoroughly after the application. It is necessary to repeat the treatment every time the disease makes its appearance. There is a leaf-spot disease that is sometimes quite injurious to Kentucky bluegrass, Bermuda, and other grasses, but so far there is no effective means known of controlling this disease.

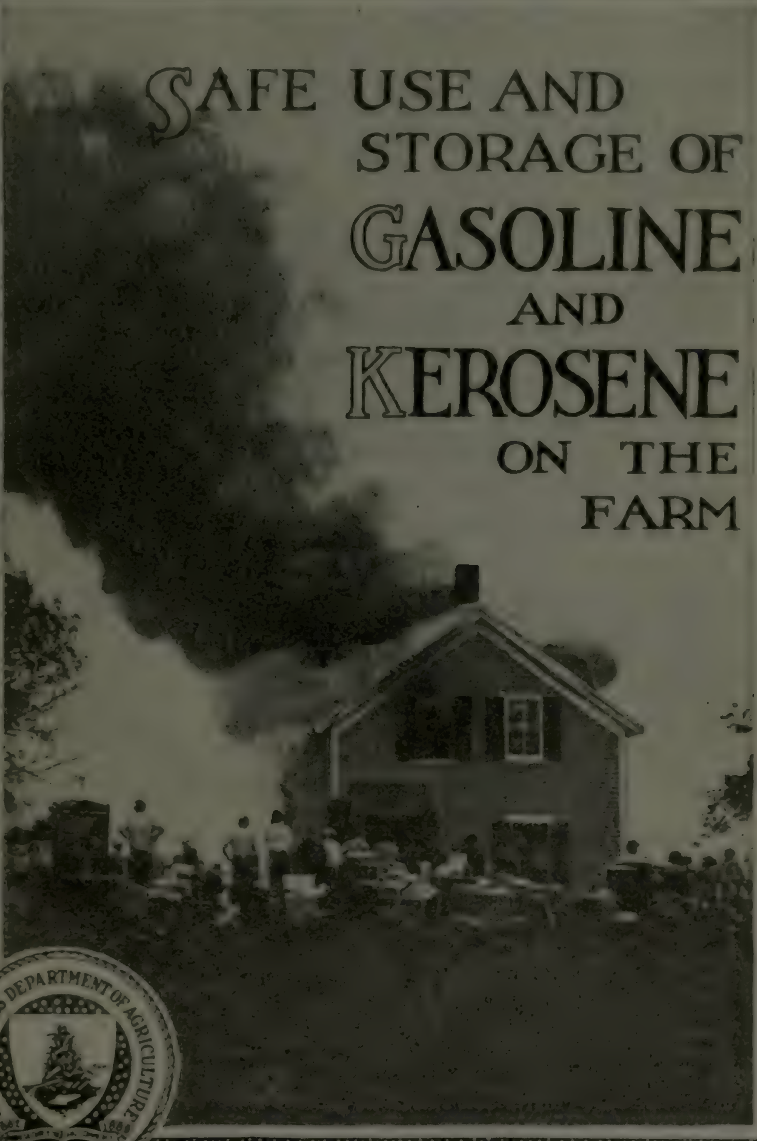
U. S. GOVERNMENT PRINTING OFFICE: 1931

For sale by the Superintendent of Documents, Washington, D. C. Price 5 cents.

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1678

SAFE USE AND STORAGE OF GASOLINE AND KEROSENE ON THE FARM



CARELESS USE AND STORAGE OF PETROLEUM and its products cause an annual fire loss of approximately $7,500,000 on farms of the United States.

Gasoline and kerosene, as well as other flammable liquids, are always potentially dangerous. Lives and property may be reasonably safeguarded against this fire and explosion hazard, however, by the proper storage and the careful handling and use of these liquids. This bulletin points out the most common hazards, and the precautions which should be observed. It also gives information on extinguishing gasoline and kerosene fires.

The United States Department of Agriculture, in an effort to reduce the extensive loss of both life and property as the result of fires on farms, is cooperating with the National Fire Protection Association, with executive offices at 60 Batterymarch Street, Boston, and other organizations and associations interested in fire prevention.

Washington, D. C. **Issued February, 1932**

THE SAFE USE AND STORAGE OF GASOLINE AND KEROSENE ON THE FARM[1]

Issued by the *Bureaus of Chemistry and Soils, Agricultural Engineering*, and *Agricultural Economics*, in cooperation with the *National Fire Protection Association*[2]

CONTENTS

	Page
Farm-fire loss from the careless use of petroleum and its products	1
Flammability of gasoline and kerosene	2
Danger of starting and reviving fires with gasoline or kerosene	2
The safe way to handle oil lamps, heaters, stoves, incubators, brooders, and lanterns	3
Hazards of cleaning with gasoline and other volatile liquids	4
Hazards of spraying disinfectants	4
Hazards of using quick-drying paints and lacquers in the home	4
Hazards of gasoline lighting and cooking systems	5
Hazards of automobiles, trucks, tractors, and stationary engines	5
Hazards of pouring gasoline from one container into another	6
Hazards of fuel-oil burners	6
Proper storage of gasoline and kerosene	7
Gasoline	7
Placing of tanks	8
Construction of tanks	9
Venting of tanks	9
Pumps	9
Piping	9
Overhead shelter	10
Kerosene	10
Drawing gasoline and kerosene	10
How to extinguish gasoline and kerosene fires	10
Foam extinguishers	10
Carbon dioxide extinguishers	12
Carbon tetrachloride extinguishers	12
Loaded-stream extinguishers	13
Use of sand, soda and sawdust, and water	13

FARM-FIRE LOSS FROM THE CARELESS USE OF PETROLEUM AND ITS PRODUCTS

PETROLEUM AND ITS PRODUCTS rank sixth in order of importance as a cause of fires on farms.[3] It is responsible for almost 7½ per cent of the total farm-fire loss[4] (excluding the loss attributed to unknown causes). In other words the estimated fire loss on farms caused by the careless use and storage of petroleum and its products amounts to $7,500,000 annually.

Probably several hundred people on farms are killed or seriously burned each year from the careless handling and storage of gasoline and kerosene.

While gasoline and kerosene, as well as other flammable liquids, are always potentially dangerous, lives and property may be reasonably safeguarded against this fire hazard by the proper storage and the careful handling and use of these liquids.

---

[1] This bulletin was prepared by Harry E. Roethe of the chemical engineering division, Bureau of Chemistry and Soils, chairman of the subcommittee of the farm-fire protection committee on the handling and storage of gasoline and kerosene. The other members of this subcommittee were Clarence Goldsmith, of the National Board of Fire Underwriters, and George F. Lewis, deputy fire marshal of the Province of Ontario.

[2] David J. Price, the chairman, and Harry E. Roethe, the secretary, both of the Bureau of Chemistry and Soils; M. C. Betts, Bureau of Agricultural Engineering; and V. N. Valgren, Bureau of Agricultural Economics, are representatives of this department on the farm-fire protection committee of the National Fire Protection Association, which assisted in carrying on investigations and in supplying valuable data for this bulletin. The committee membership includes representatives of interested agencies in the United States and Canada.

[3] According to statistics of the National Board of Fire Underwriters.

[4] Estimated by the farm-fire protection committee to be approximately $100,000,000 annually.

FLAMMABILITY OF GASOLINE AND KEROSENE

All grades of gasoline are highly flammable and dangerous. They always should be treated as such.

Gasoline has been called "liquid dynamite" because of the explosive violence which results from the ignition of gasoline vapor mixed with air in certain proportions. The various grades of gasoline differ somewhat in chemical and physical properties. The better grades are much more hazardous to handle than others. As they are much more volatile, they mix with air in larger proportions and pass into vapor form (evaporate) more rapidly.

Gasoline vapor is heavier than air; consequently it will float along near the ground, like an invisible stream, for considerable distances. In a lean mixture (a little less than 2 per cent) 5 gallons of gasoline would produce 8,000 cubic feet of burnable or mildly explosive gas (gas-air mixture), or enough to fill a room having the dimensions 20 by 40 by 10 feet. If ignited, and if no heat is lost and the products of combustion are at atmospheric pressure, this mixture would expand to eight or ten times the initial volume of air and gas vapor, with destructive results.

As with other gases and vapors, before an explosion of gasoline vapor can occur a definite proportion of air and gasoline vapor must be present. In 100 parts by volume of air and gasoline, an explosion will not take place if there is less than 1½ or more than 6 parts of gasoline vapor.[5] In other words, the explosive range is between 1½ and about 6 per cent of gasoline vapor. This range of explosibility is narrow as compared with that of many other mixtures of combustible gases and air; nevertheless in the lower limit there is a very small proportion of gasoline vapor, indicating the great importance of not allowing even a little gasoline to be exposed in a room or confined space.

Kerosene (lamp oil or coal oil) is not highly flammable like gasoline. When heated, however, it gives off dangerous vapors which are capable of forming explosive mixtures with air. Generally kerosenes have flash points[6] above 100° F., whereas the flash points of gasoline will range down to lower than 0° F.

DANGER OF STARTING AND REVIVING FIRES WITH GASOLINE OR KEROSENE

With considerable regularity the press contains news items of lives and property destroyed as a result of an attempt to start or revive a fire in a stove or a furnace with flammable liquids, generally kerosene. (Fig. 1.) This practice is dangerous, but it is followed to an alarming extent. The reason must be either ignorance or the willingness to take a chance.

The hazard of fire from the burning of the liquids themselves is serious, but the hazard of ignition of the explosive gases formed is doubly serious. The safe rule to follow is never try to start or revive a fire with gasoline or kerosene.

---

[5] Bureau of Mines, Tech. Paper 115. Inflammability of Mixtures of Gasoline Vapor and Air.

[6] The temperature at which flammable vapor given off from fuel oil will ignite temporarily, or flash.

THE SAFE WAY TO HANDLE OIL LAMPS, HEATERS, STOVES, INCUBATORS, BROODERS, AND LANTERNS

Kerosene lamps, heaters, stoves, incubators, brooders, and lanterns should be carefully handled. They should never be filled while burning. In extinguishing lighted lamps, lanterns, and heaters turn down the wick a little and put out the flame by blowing over the top of the burner. It is dangerous to blow out the flame from underneath or to turn the wick down very low.

Wicks and burners should be kept clean. Boil the burners occasionally in soda lye or soap. An explosion may result from defective wicks which do not entirely fill the wick tube section of the burner. Such wicks permit free communication between the flame and the space above the oil in the reservoir.

Kerosene lamps should not be made of glass. They should be of metal, with broad, metal bases. Lamp shades should be of material that will not burn. Never place lamps near the edge of a table or near curtains.

Lanterns should be free from leaks, and lighted lanterns when not being carried should be hung on substantial hooks or supports out of the wind, away from cobwebs and other combustible materials and at a height sufficient to insure protection against damage or disturbance.

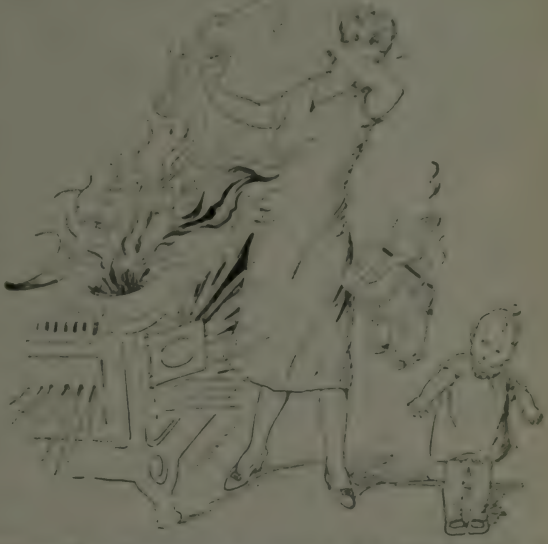


FIGURE 1.—Never start or revive a fire with gasoline or kerosene

Do not place kerosene lamps or lanterns near stoves or in other warm places because the heating of the kerosene in the receptacle will form vapors that will cause "flaring."

Do not carry lighted oil heaters about the house. Children should be cautioned about playing near them or upsetting them.

Brooders should be placed in an isolated location. It is dangerous to operate them in the house or barn. Overheating should be guarded against.

Although the fire hazard from incubators is not considered as great as that from brooders, they should be operated with care, especially when in the home. Guard against overheating. Use brooders and incubators which bear the label of and are listed by the Underwriters' Laboratories.

HAZARDS OF CLEANING WITH GASOLINE AND OTHER VOLATILE LIQUIDS

Cleaning with gasoline, benzine, and other flammable, volatile liquids is distinctly hazardous and should not be practiced, especially indoors. During cleaning operations vapors are given off which may form explosive mixtures with the air. All that is needed then to produce an explosion is a source of ignition, such as an open flame from lighted matches, kerosene lamps, stoves and heaters, gas jets, mantles or burners; a lighted cigar, cigarette, or pipe; a metallic spark, an electric spark, or a static spark. Many explosions with loss of life have resulted from the ignition of these vapors by open flames and electric sparks.

Also several serious explosions and fires have resulted from the ignition of gasoline vapors both indoors and outdoors by static sparks caused by the rubbing of fabrics and kid gloves on the hands with the liquid. In performing what they thought the harmless task of washing silk dresses and kid gloves with gasoline, these persons did not realize that they were exposing themselves to a menacing explosion and fire hazard.

FIGURE 2.—Use a nonflammable liquid such as carbon tetrachloride for dry-cleaning at home

If it is necessary to do any "dry-cleaning" at home, a nonflammable liquid such as carbon tetrachloride should be used in small quantities. (Fig. 2.) Carbon tetrachloride in any considerable quantity should be used out of doors as it is toxic (slightly anæsthetic). Persons have been overcome by using only a gallon of it in a closed room.

Other volatile oil solvents, sold under various trade names, with a flash point approximately the same as that of kerosene, are now being used to some extent for dry-cleaning purposes in the home. They should be used out of doors, however, and only in the daytime, well away from flame or sparks that might cause ignition.

HAZARDS OF SPRAYING DISINFECTANTS

Spraying disinfectants in the home for the purpose of killing flies, moths, and ants is now a common practice. Most of these liquids, if not all of them, are flammable. Spraying, therefore, should not be done in the presence of an open flame or a lighted cigar, cigarette, or pipe, or other source of ignition, and the container holding the liquid should be kept closed and away from heat.

HAZARDS OF USING QUICK-DRYING PAINTS AND LACQUERS IN THE HOME

Spraying quick-drying enamels, lacquers, or finishes in the home has created a new and insidious explosion and fire hazard. Pyroxylin lacquers, brushing lacquers containing pyroxylin, and, as a matter of fact, most materials sold under this designation, contain amyl acetate, alcohol, and similar liquids which are highly flammable.

The vapor formed by these lacquers and finishes is heavier than air and highly flammable. It will fall to the surface of the ground and may be carried considerable distances. If the proper mixture of vapor and air is present as well as a source of ignition, such as an open flame, a lighted pipe, cigar, or cigarette, a static spark, a metallic spark, or an electric spark, an explosion will result. These vapors may even flash back to the user from a flame located at a seemingly great enough distance for safety.

In general, this hazard can be guarded against by adequate ventilation. The application of these quick-drying paints and lacquers either by sprayers operated by hand or by those attached to vacuum cleaners should, therefore, be carried on out of doors whenever possible, so that the vapors will be quickly dissipated and carried away in the open air. If of necessity spraying is carried on indoors, every precaution should be taken to insure that there are no open lights, fires, sparks, or other sources of ignition near by and that the windows and doors are open. Smoking should be strictly prohibited.

HAZARDS OF GASOLINE LIGHTING AND COOKING SYSTEMS

In gasoline lighting and cooking systems many hazards can be introduced by faulty design and construction of equipment, such as corrodible material, improperly made joints, and valves of poor design. Only the best and most reliable types of this equipment should be used, such as those which have been tested and listed by the Underwriters' Laboratories, or other well-recognized authorities. Even then certain inherent hazards are possible. The installation should be in strict accordance with the manufacturer's directions and with the recommendations[7] of the National Fire Protection Association.

With the operation of this equipment the hazard of explosive vapors is again introduced. The tanks should be filled carefully, and only during the daytime. They should never be filled in the vicinity of an open flame or other sources of ignition.

HAZARDS OF AUTOMOBILES, TRUCKS, TRACTORS, AND STATIONARY ENGINES

Stationary and automotive engines may backfire when started. If this happens in the vicinity of combustible materials or explosive gases and dusts a fire may result. Combustible materials should be kept away from such equipment even when in apparently normal operation because there is always the chance of a fire through an overheated or faulty muffler, hot or burning carbon deposits, and faulty ignition. It is dangerous, therefore, to house or use internal-combustion engines or automotive equipment so driven, in barns and granaries.

---

[7] Regulations of the National Board of Fire Underwriters for the Installation, Maintenance, and Use of Gasoline Vapor Gas Machines, Lamps, and Systems as Recommended by the National Fire Protection Association, edition of 1926; and Regulations of the National Board of Fire Underwriters for the Installation and Operation of Compressed Gas Systems Other than Acetylene for Lighting and Heating as Recommended by the National Fire Protection Association, edition of 1927.

Do not start automobile or other gasoline engines in a closed garage or other building. (This precaution does not apply to engines equipped with a fixed exhaust to the outside of the building.) In starting such engines it frequently happens that the mixture is too rich. As a consequence, deadly carbon monoxide (CO) is given off. This gas in very small quantities is fatal to human life. Furthermore, the fact that it is odorless and colorless and can not be detected by the sense of smell and the sense of sight makes it doubly dangerous. Before starting engines in confined spaces always open doors and windows in order to provide ventilation and permit the removal of carbon monoxide.

Cleaning automobiles, tractors, and stationary engines with gasoline is dangerous. The vapor produced presents an explosion hazard, the source of ignition readily being supplied by an open flame, cigar or cigarette coals, static electricity, the ignition system of the engine, or a spark caused by striking two pieces of metal together.

HAZARDS OF POURING GASOLINE FROM ONE CONTAINER INTO ANOTHER

Dangerous vapors are given off when gasoline is poured from one container into another or when the liquid is exposed to the air, thus forming an explosive mixture of vapor and air which may be ignited very easily. Consequently such pouring should not be done near open flames or lights, or near engines and motors while they are running. Smoking, and electric and metallic sparks also are sources of ignition that should be guarded against.

Another source of ignition is static electricity. Static electricity can be generated by gasoline in a number of ways. It is generated, for example, by gasoline flowing through either a metal pipe or a rubber hose, by gasoline being poured from one container into another or being filtered through chamois, and by gasoline swishing about inside a tank or tank wagon. Unless the containers or other equipment are grounded the static charge accumulates and eventually escapes to the ground by jumping across or bridging near-by points or areas. A spark or series of sparks is thus produced, and an explosion of the vapor may result. To prevent such an occurrence the containers or other equipment should be grounded or be in contact with the ground.

In pouring gasoline from a can or a drum into another container with a funnel, for example, a simple expedient is to keep the mouth of the container from which the gasoline is being poured in contact with the funnel, and the funnel in turn in direct contact with the receptacle being filled, the latter resting on the ground. When filling the tank of the tractor, automobile, or gas engine it is a simple matter to keep the metal nozzle of the hose in contact with the mouth of the tank, thus preventing the passage of a static spark. An additional precaution is to touch the filling nozzle to some metal part of the automobile or tractor before placing it in the mouth of the tank.

HAZARDS OF FUEL-OIL BURNERS

Although on farms the use of oil for heating the home is limited, the subject is of sufficient importance to be touched upon in this bulletin.

As with heating apparatus of other kinds, a fire hazard is associated with domestic oil burners. Fire records in the urban districts indicate that the greatest number of fires with property-damage loss attributed to domestic oil burners are caused by the failure of automatic shut-off valves to function and thus stop the supply of oil; loose connections and leaking pipes; back-firing; defective burners; and careless operation.

It is of great importance, therefore, that only domestic oil burners be selected or used which have been tested by and bear the label of the Underwriters' Laboratories. This label is assurance to the buyer or user that the oil burner bearing the label has been safeguarded to a reasonable degree and is so made that it may readily be installed in accordance with the recommendations of the National Fire Protection Association.

Oil-burning systems involve the installation of tanks, piping, the burner proper, and, in some cases, electrical wiring. In handling all this equipment, the recommendations of the National Fire Protection Association[8] and the National Electrical Code should be followed. The installation should be made only by competent, reliable workmen, strict attention being paid to the manufacturer's instructions. The principal object to keep in mind when installing tanks and piping for an oil burner is the complete delivery of the oil to the burner.

The equipment, once installed, should receive adequate and intelligent attention. When in operation, the oil burner should be looked over at least once a day, and preferably oftener. Care should be taken to see that automatic devices or provisions to prevent flooding of the burner are always in good working order.

Oils used in domestic oil burners should have a flash point of not less than 100° F. or the local legal minimum.

PROPER STORAGE OF GASOLINE AND KEROSENE[9]

With the more or less general use of tractors, stationary engines, and automobiles on farms, the hazard incident to the storage of flammable liquids has become serious. It is very important that the farmer who uses these liquids on his farm give serious consideration to their storage. The following suggestions are offered.

GASOLINE

Gasoline should never be stored or handled in open containers in any building. All containers for gasoline should be red, and the word GASOLINE should be painted on them in a conspicuous manner.

In buildings (except a special storage room or fire-resistive building) gasoline should be stored in a sealed container or safety can (fig. 3), the total quantity thus stored not to exceed 1 gallon.

Outside buildings, gasoline should be stored in substantially constructed steel drums (fig. 4) of not more than 60 gallons capacity, equipped with a pump, the drum or drums being at least 75 feet from the nearest building; or in an approved underground tank (fig. 5) equipped with a pump, the tank being at least 10 feet from the nearest building. Such tanks may be had in capacities ranging upward from 110 gallons.

---

[8] Regulations of the National Board of Fire Underwriters for the Installation of Oil-Burning Equipments and for the Storage and Use of Oil Fuels in Connection Therewith as recommended by the National Fire Protection Association, edition of 1928.

[9] The material on the placing, construction, and venting of tanks, pumps, and piping was taken from Suggested Ordinance Regulating the Use, Handling, Storage, and Sale of Flammable Liquids and the Products Thereof. Adopted 1926, published by the National Fire Protection Association.

PLACING OF TANKS

The top of an underground tank should not be less than 2 feet below the surface of the ground, and should be below the level of any piping to which the tank may be connected. Instead of being buried 2 feet underground, the tank may be buried under 12 inches of earth, and a cover of reinforced concrete at least 6 inches in thickness provided. This cover should extend at least 1 foot beyond the outline of the tank in all directions and should be placed on a firm, well-tamped earth foundation.

FIGURE 3.—Safety can for storing small quantities of gasoline

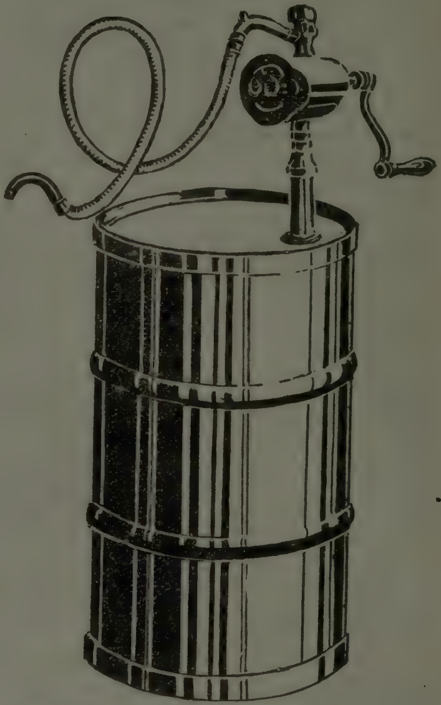


FIGURE 4.—Steel drum for storing gasoline

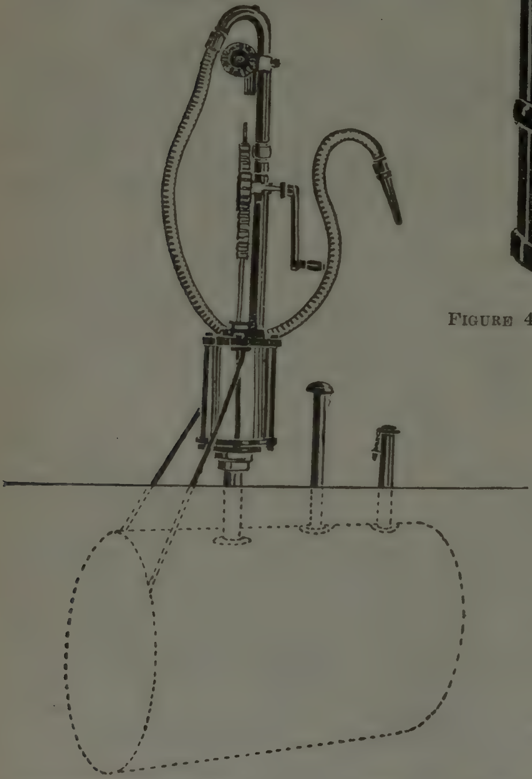


FIGURE 5.—Underground tank and pump for storing gasoline

A tank that can not be entirely buried should be covered over with earth to a depth of at least 2 feet, with a slope on all sides not steeper than 1½ feet horizontal to 1 foot vertical.

CONSTRUCTION OF TANKS

Tanks, including top, sides, and bottom, should be constructed of open-hearth steel or wrought iron of a thickness not less than that specified in Table 1. No seconds should be used. All material lighter than No. 7 U. S. Standard Gage should be galvanized.

TABLE 1.—*Thickness and weight of metal for gasoline and kerosene tanks*

Capacity (gallons)	Minimum thickness of metal	Pounds per square foot
	Gage[1]	*Pounds*
1 to 285	16	2.50
286 to 560	14	3.125
561 to 1,100	12	4.375
1,101 to 4,000	7	7.50

[1] U. S. Standard.

Tanks should be riveted, welded, or brazed, and should be soldered, caulked, or otherwise made tight. They should also be thoroughly coated on the outside with tar, asphaltum, or other suitable rust-resisting material. All pipe connections should be made through flanges or metal reinforcements securely riveted, welded, or bolted to the tank, and should be absolutely tight. All openings should be gas-tight, except the breather vent, which should be screened.

VENTING OF TANKS

An open galvanized-iron vent pipe arranged for proper draining, or an automatically operated vent, should be provided for every tank that may contain flammable vapor. The lower end of the vent pipe should not extend through the top into the tank for a distance of more than 1 inch.

Vent openings should be screened (preferably by 40 by 40 but not less than 30 by 30 noncorrodible wire mesh or its equivalent). The area should be sufficient to permit escape of air or vapor during the filling operation. Vent pipes should be provided with weatherproof hoods.

PUMPS

Flammable liquids should be drawn from tanks by pumps so constructed as to prevent leaking or splashing.

PIPING

All piping used in systems for flammable liquids should be of the standard full-weight wrought-iron, steel, or brass type (for working pressures less than 100 pounds per square inch), with suitable brass or galvanized malleable-iron or steel fittings.

Outside piping within 5 feet of the ground level should be protected against any mechanical injury. Inside piping should be rigidly supported.

All pipes carrying flammable liquids should pitch toward the tanks without any traps or pockets and should enter tanks at the top.

No rubber or other packings, and no flanges should be used. If unions are used, at least one face should be of brass, with close-fitting conical joints. Litharge and glycerin, shellac, or other suitable material should be used on pipe joints.

OVERHEAD SHELTER

Drums and tanks may be provided with a simple, inexpensive, overhead shelter to afford protection against the weather. Such a shelter will not give opportunity for the accumulation of gasoline vapor, as would an inclosed structure.

KEROSENE

Kerosene should not be stored or handled in open containers in any building.

Only moderate quantities of kerosene should be stored in buildings and then only in closed containers or substantial drums equipped with a pump. The containers should be kept at a safe distance from furnaces or other heating appliances and from flammable rubbish.

Large quantities of kerosene should be stored outside buildings in substantial drums equipped with a pump or in an underground tank equipped with a pump. (See details regarding construction and placing of underground tanks and appurtenances under Gasoline, p. 8 to 10.)

It is important that cans, barrels, and drums holding kerosene be kept clean and that the word KEROSENE be painted on them in a conspicuous manner.

DRAWING GASOLINE AND KEROSENE

Gasoline and kerosene should never be drawn or handled in the presence of open flames or fire. If it is necessary to do this at night, light should be afforded by electric flashlight or incandescent electric lamps installed in compliance with the National Electrical Code.

Drums for gasoline and kerosene should be provided with caps, plugs, or bungs, and these should always be replaced immediately after the container is emptied.

Smoking or the use of matches should not be permitted where vapors of flammable liquids are present or are likely to be formed.

HOW TO EXTINGUISH GASOLINE AND KEROSENE FIRES[10]

Fires are commonly put out in two ways: (1) By cooling the burning materials to below their burning temperature; and (2) by smothering the fire, thus depriving it of the air (oxygen) necessary to support combustion.

Gasoline and kerosene fires are best extinguished by smothering, as by a foam or gas. The following appliances are recommended for fighting such fires: Foam extinguishers, carbon dioxide extinguishers, carbon tetrachloride extinguishers, loaded stream extinguishers.

It is important that only first-aid fire appliances which have been tested by and bear the label of the Underwriters' Laboratories be selected or used, and that they be properly operated and maintained.

FOAM EXTINGUISHERS

One 2½-gallon foam extinguisher (fig. 6) is considered a unit of first-aid fire protection for gasoline and kerosene fires.

When an extinguisher of this type is inverted two solutions contained in it mix and react, producing a foam under sufficient pressure to furnish a forceful stream. One solution is sodium bicarbonate and a foam-producing agent, and the other is a water solution of aluminum sulphate. About 20 gallons of foam are produced by the $2\frac{1}{2}$-gallon extinguisher.

---

[10] The material on this subject is based on the pamphlet How to Put Out a Fire, published by the National Fire Protection Association; and Regulations of the National Board of Fire Underwriters for the Installation, Maintenance, and Use of First Aid Fire Appliances as recommended by the National Fire Protection Association, effective March 1, 1930.

The foam extinguishes a fire by both the cooling and smothering effects. Containing a liberal quantity of water, it has considerable cooling effect. The foam itself smothers the fire by clinging to the burning materials and excluding air (oxygen). This extinguisher is effective on fires in small quantities of flammable liquids in vats or other open vessels, or on floors, where the foam may be retained as a blanket on the burning material.

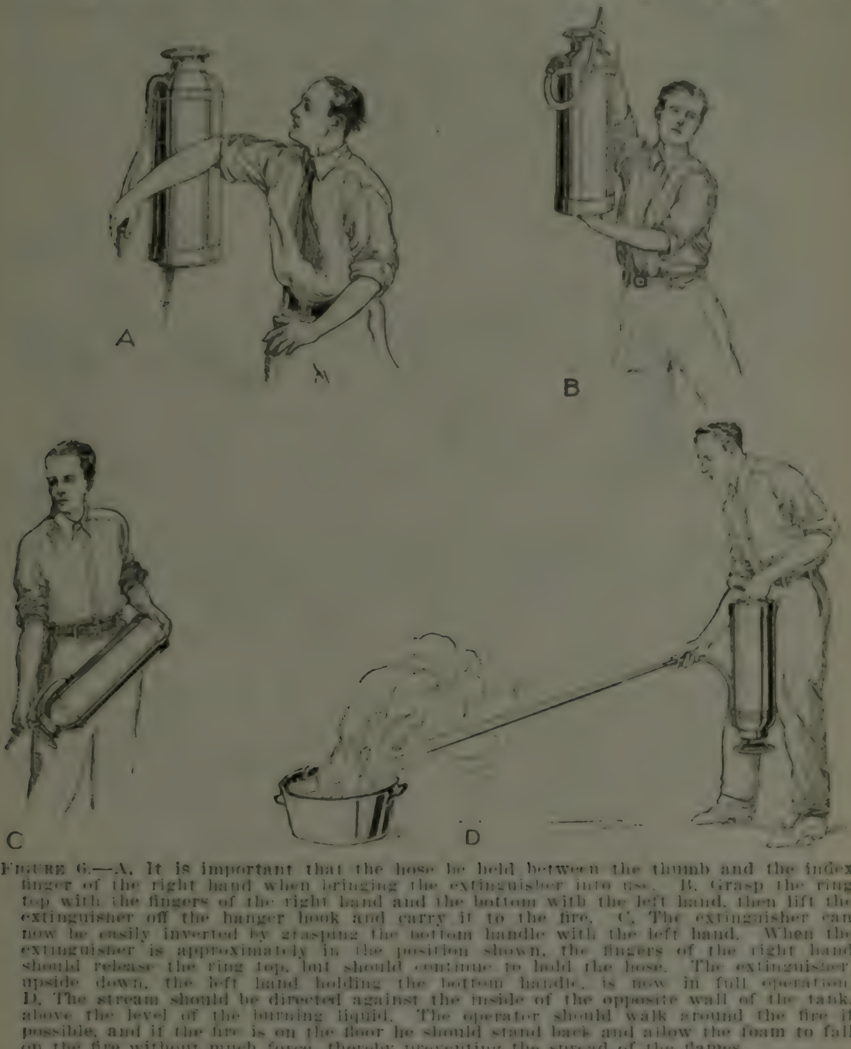


FIGURE 6.—A, It is important that the hose be held between the thumb and the index finger of the right hand when bringing the extinguisher into use. B, Grasp the ring top with the fingers of the right hand and the bottom with the left hand, then lift the extinguisher off the hanger hook and carry it to the fire. C, The extinguisher can now be easily inverted by grasping the bottom handle with the left hand. When the extinguisher is approximately in the position shown, the fingers of the right hand should release the ring top, but should continue to hold the hose. The extinguisher, upside down, the left hand holding the bottom handle, is now in full operation. D, The stream should be directed against the inside of the opposite wall of the tank, above the level of the burning liquid. The operator should walk around the fire if possible, and if the fire is on the floor he should stand back and allow the foam to fall on the fire without much force, thereby preventing the spread of the flames

Although the stream is usually most effective when directed from a distance, it may also be used close to the fire. In case of necessity it can be directed effectively from a distance as great as 30 to 40 feet.

CARBON DIOXIDE EXTINGUISHERS

There are two principal sizes in the hand extinguishers of the carbon dioxide type (fig. 7), one containing approximately 7½ pounds of carbon dioxide and the other 15 pounds. One 15-pound extinguisher or two 7½-pound extinguishers are considered a unit of first-aid fire protection for gasoline and kerosene fires.

From two-thirds to three-fourths of the gas contents in the cylinder is liquefied by pressure. Because of rapid expansion and high heat capacity this gas, when released, instantly freezes into a dry carbonic snow, which is intensely cold, −110° F. It does not melt, but evaporates directly into a gas. The fire is extinguished by the blanketing effect of the carbonic gas. The carbon dioxide is a nonconductor of electricity.

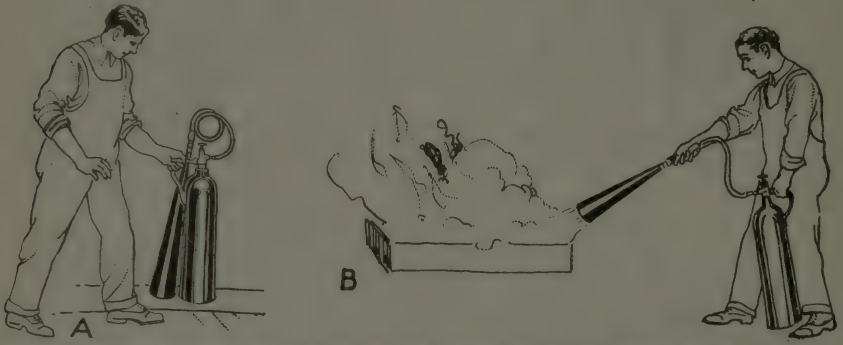


FIGURE 7.—A, The extinguisher is removed by grasping the handle with the left hand. It should be carried to the fire by means of the handle. To release the gas the valve is opened by turning it counterclockwise. B, Direct the discharge as close to the fire as possible, applying it first at the edge and bottom of the fire and progressing forward and upward, moving the discharge horn slowly from side to side. Continue the discharge even after the fire has been extinguished in order to cool the liquid and prevent possible reflashing

This type of extinguisher is effective on fires in small quantities of flammable liquids in vats or other open vessels, or on floors, where the blanketing effect of the extinguishing gas is of value. It has a maximum range of about 8 feet, but best results are obtained by directing the discharge as close to the fire as possible. This extinguisher does not need protection against freezing.

CARBON TETRACHLORIDE EXTINGUISHERS

Two 1-quart or two 1½-quart carbon tetrachloride extinguishers (fig. 8) ordinarily constitute a unit of first-aid fire protection. Two extinguishers of the 1-gallon size are suggested for more effectively fighting gasoline and kerosene fires. By means of the hand pump a stream of carbon tetrachloride is expelled on the fire. The heat of the fire causes this liquid to vaporize, producing an incombustible, heavier-than-air gas, which forms a blanket over the burning material, cutting off the supply of air (oxygen) necessary to support combustion. Carbon tetrachloride is a nonconductor of electricity.

This type of extinguisher is effective on fires in small quantities of flammable liquids in vats or other open vessels, or on floors, where the gas formed by the heating of the extinguishing liquid may be retained as a blanket on the burning material. Although the stream is usually most effective when used close to the fire, in case of necessity it can be directed from a distance of 20 feet.

The carbon tetrachloride extinguisher is compact and needs no protection against freezing. Care should be taken to ventilate small rooms and confined spaces immediately after using this extinguisher.

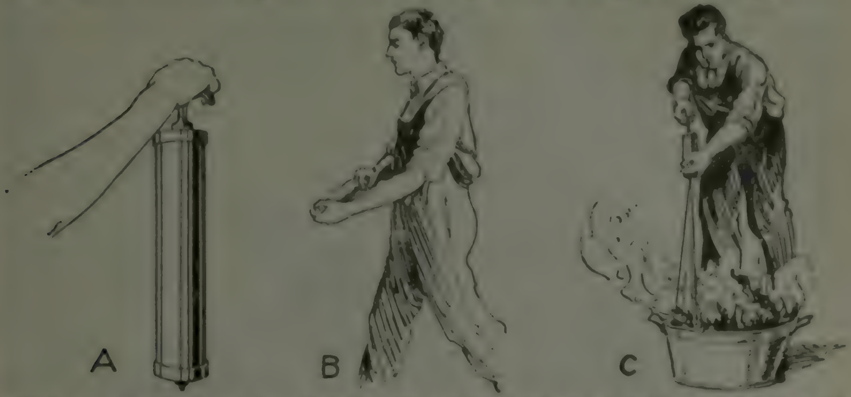


FIGURE 8.—A, Remove the extinguisher from the wall bracket by grasping the handle and pulling outward. B, On the way to the fire unlock the handle by turning. If the device is of the air-pump type, hold a finger over the nozzle and pump up the pressure. C, Direct the stream at the base of the flames and work around the fire rapidly. If the fire is in an open container or tank, direct the stream against the inside of the opposite wall above the level of the burning liquid

LOADED-STREAM EXTINGUISHERS

Two 1¾-gallon extinguishers of the loaded-stream type (fig. 9) are considered a unit of first-aid fire protection for gasoline and kerosene fires. This extinguisher is effective on fires in small quantities of flammable liquids in vats or other open vessels, or on floors. The chemicals used are a special acid contained in a sealed bottle, and a special antifreeze solution containing certain alkali metal salts with which the acid will react.

When the extinguisher is inverted and bumped on the ground the acid reacts with the antifreeze solution, generating a gas which expels the contents through the hose. Although the stream is most effective when used close to the fire, in case of necessity it can be directed effectively from a distance of 30 to 40 feet.

This type of extinguisher does not need to be protected against freezing as it employs an extinguishing liquid having a freezing point of −40° F.

USE OF SAND, SODA AND SAWDUST, AND WATER

SAND

Sand is useful on gasoline and kerosene fires where the smothering effect can be utilized, as on small quantities of burning flammable liquids on a wooden floor. Obviously it has no effect in extinguishing flammable liquid fires in open vessels.

Five 12-quart pails filled with dry, clean sand, and equipped with scoops, or a 4-bushel bin filled with sand, with two or more shovels, make up a unit of first-aid fire protection.

Sand pails are not intended to be used alone, but in connection with other extinguishers.

SODA AND SAWDUST

Soda and sawdust are for use only on fires in heavy flammable liquids in open vessels, where the mixture may be spread as a blanket on the fire. It should be supplemented with other first-aid fire protection.

A substantial galvanized iron or steel bin (1½ by 1½ feet and 3½ feet high with reinforced edges and sides tapered downward) of 8 bushels capacity and provided with two or more scoop shovels, constitutes a unit of first-aid fire protection. Clean, dry sawdust, evenly mixed with sodium bicarbonate in the proportion of 10 pounds of soda to 1 bushel of sawdust, is the extinguishing agent.

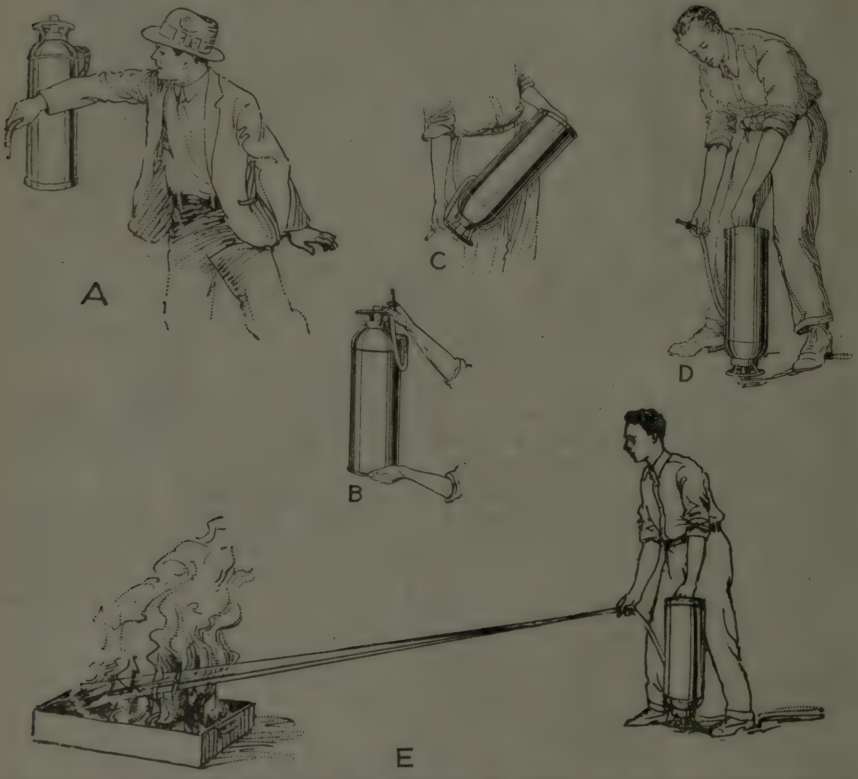


FIGURE 9.—A, The hose should be held between the thumb and the index finger of the right hand when bringing the extinguisher into use. B, Grasp the ring top with the fingers of the right hand and the bottom with the left hand. Then lift the extinguisher off the hanger hook and carry it to the fire. C, Invert the extinguisher by grasping the bottom handle with the left hand, continuing to hold the hose and the ring top with the right hand. D, With the extinguisher in an inverted position bump it on the floor or other hard surface, thus pressing in the plunger pin in the cap. E, Direct the stream against the inside of the opposite wall of the container above the level of the burning liquid. Walk around the fire if possible. If the fire is on the floor direct the stream at the base of the flames. Follow the flames with the stream and cover as much of the burning area as possible

WATER

Water should not be used to fight gasoline and kerosene fires. In fact, the use of water will make control of the fire more difficult, as it may wash the burning liquid about and thus scatter the fire over a larger area.

U. S. GOVERNMENT PRINTING OFFICE: 1932

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1679

POP CORN

POP CORN and field corn require the same kinds of soil and climate and the same general methods of cultivation for successful production.

The best yields of pop corn come from productive soils that are not too light or sandy and contain abundant organic matter.

The essential requirement in cultivating pop corn is to control weeds. Much of this can be accomplished cheaply by using harrows, weeders, and similar tools before or immediately after the pop-corn plants emerge.

A productive soil and thorough cultivation are even more important in the production of pop corn than of field corn, because pop-corn value depends largely upon quality, and poor growing conditions are reflected in poor quality as well as in low yield.

The production of pop corn is a highly specialized business, and profits depend at least as much upon the ability to market successfully as upon growing the crop.

Much of the pop corn of commerce is grown on contract in localized areas where facilities are available for handling it efficiently on a large scale.

Anyone undertaking production of pop corn for the general market should first assure himself that his crop can be sold if it is produced.

Small-scale production for supplying directly the needs of near-by cities and towns may be a profitable occupation for those who are especially suited to this kind of undertaking. Such a venture, however, also requires merchandizing ability to make it profitable.

This bulletin supersedes Farmers' Bulletins 553 and 554, Pop Corn for the Home, and Pop Corn for the Market.

Washington, D. C. **Issued October, 1931**

POP CORN

By Arthur M. Brunson, *Agronomist*, and Carl W. Bower, *Assistant Agronomist, Division of Cereal Crops and Diseases, Bureau of Plant Industry*[1]

CONTENTS

	Page
Introduction	1
Popping and other qualities	2
Varieties	3
Seed selection	6
Soils, rotations, and fertilizers	7
Planting and cultivating	8
Harvesting	11
Storing	12
Marketing	14
Insects and diseases	17
Does it pay to grow pop corn?	17

INTRODUCTION

THE CULTURE of pop corn almost certainly antedates the discovery of America by Columbus. Although the records are meager there is good evidence that pop corn was known and used by the Indians of both North America and South America before the coming of the white man.

The importance of pop corn as an article of commerce has developed since about 1880. The use of pop-corn confections and the rapid increase in pop-corn concessions in connection with amusement parks, moving-picture theaters, and the like has greatly increased the demand for a reliable bulk product and has made a profitable outlet for those who desire to grow pop corn on a commercial scale. In recent years the development of the small electric popper has given an added impetus to the use of pop corn in the city home. Although still largely grown in the family garden for home and local use, it is probable that with the increasing ratio of urban population and the increasing tendency toward specialization in agriculture, commercial production will become more and more important.

It is probable that pop corn is grown in every State in the Union as a garden crop to supply the home. Only a few States, however, are of importance in producing the commercial crop. Iowa is easily the leading State, with Nebraska second in production. The production in these two States has increased greatly during the 10-year period, 1921–1930, but the acreage and yield have shown wide fluctuations from year to year.

The average acreage for Iowa during this 10-year period was 25,884 acres, and the average yield was 1,606 pounds to the acre. Most of this acreage is concentrated in Sac and Ida Counties, in western Iowa. Sac County raises more pop corn than any other county in the United States and probably more than any similar area in the world. Pop-corn companies have cribs and elevators, especially designed to handle the crop satisfactorily, distributed throughout this territory.

The average acreage for Nebraska for the 10-year period, 1921–1930, was 8,600 acres, and the average acre yield 1,115 pounds. Valley

---

[1] In cooperation with the Kansas Agricultural Experiment Station, Manhattan, Kans.

County, in the central portion, has nearly two-thirds of the State acreage, and practically all commercial pop corn of the State is raised in the central and northeastern part.

POPPING AND OTHER QUALITIES

All starchy corns may be placed in one of the four classes—pop corn, flint corn, dent corn, or flour corn—on the basis of the distribution and relative proportions of horny and soft starch in the endosperm. The endosperm of the best strains of pop corn is corneous or hard throughout or contains only a small core of soft starch near the center. (Fig. 1.) In flint corn the endosperm consists of a small quantity of soft starch, near the embryo, completely surrounded by corneous starch. In dent corn the corneous starch is confined mainly to the sides of the kernels, soft starch constituting a larger proportion than in flint corn. In flour corn the endosperm is practically all made up of soft starch and contains only traces of hard starch.

The popping properties of the different kinds of corn follow rather closely the relative proportions of hard or corneous starch in the endosperm. Pop corn, with the greatest proportion of hard starch, is far better than the others in "poppability." Flint corn may pop poorly to fairly well, depending on the strain. Dent corn rarely will pop, though occasionally a few kernels will pop feebly. Flour corn will not pop at all.

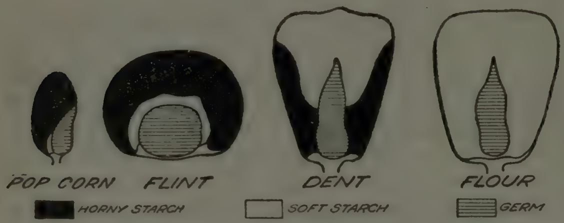


FIGURE 1.—Diagrammatic representation of location and relative proportions of horny starch and soft starch in the four main classes of starchy corn

The popping process is due to the sudden liberation of pressure produced by steam generated within the kernel. The source of the steam is the moisture contained in the kernel. The colloidal matrix in which the starch grains are embedded within the cell confines this steam until the pressure becomes great enough completely and suddenly to rupture the original structure.

The quality of pop corn depends upon its flavor and tenderness. A large expansion during popping is closely associated with tenderness and is desirable also because it means a large volume of the finished product from a given quantity of pop corn. Popping expansion depends upon three major conditions: (1) The inherent structure of the kernels, (2) their moisture content, and (3) the proper application of heat.

Just as pop corn pops better than flint corn, so pop corn having the least soft starch in the kernels pops better than that having more soft starch. This freedom from soft starch, indeed, probably is the most important characteristic determining the popping quality of different strains.

Good expansion during popping may be expected from pop corn containing from 12 to 15 per cent of moisture, the best moisture content being 13 to 14 per cent. The volume expansion decreases rapidly for samples having less than 11 or more than 16 per cent of moisture. Corn at these limits can be popped successfully, therefore, only if it is first treated so as to increase or decrease the moisture content. Pop corn containing too much moisture will dry rapidly if exposed to the air in heated rooms. The moisture content can be increased, on the other hand, by sprinkling very lightly with water, just enough to dampen the kernels slightly, and then storing the corn in tight containers 24 to 48 hours, or until this moisture is thoroughly absorbed. In general, pop corn stored where it is in contact with the outside air will have a moisture content suitable for popping.

In popping corn the heat should be applied evenly and neither too quickly nor too slowly. Best popping occurs when heat is applied so that popping begins in about one and a half minutes.

VARIETIES

Pop corn varieties may be classified into two main groups—the rice corns, which have sharply pointed kernels, and the pearl corns, which have smooth, rounded kernels. Each group contains several distinct varieties, divided on the basis of kernel color, size, and shape of ear, length of growing season, etc. Practically all varieties have white cobs. Although 50 or more varieties are listed by seedsmen and propagated in a small way by individual growers, nearly all commercially raised pop corn is of three types—White Rice, Jap, and pearl. (Fig. 2.) The main centers of production, Iowa and Nebraska, are limited almost exclusively to White Rice and Jap.

White Rice has been the backbone of the pop-corn trade; it has been used especially for pop-corn confections and concession stands and probably is still the most widely grown variety. Where well adapted, the stalks grow 6 to 7 feet tall and produce about two-thirds as many pounds of ear corn per acre as good dent corn grown on the same land. Typical ears are about 7 inches long and have 16 to 20 rows.

Jap, also known as Little Jap, Japanese, Jap Hull-less, etc., has become increasingly popular during the last few years because of its excellent popping qualities and tender texture. The plants are smaller, being on an average about 5 to 6 feet tall under good conditions, and having a characteristic thickened clublike tassel. The yield is only about two-thirds that of White Rice. The market price is usually enough higher, however, just about to compensate for the difference in yield, although the price ratio fluctuates somewhat from year to year in accordance with changes in supply and demand. Jap corn has a very characteristic short thick ear, 3 to 4 inches long, with 30 to 40 rows of kernels. Usually the rows are irregular and difficult to distinguish. The kernels are of the sharp-pointed rice type and are exceptionally long and narrow. (Fig. 3.) Many growers prefer a multiple-tipped or fasciated cob, that having three points being considered the ideal type. Practically all of the Jap corn is white, although a few growers are producing a Yellow Jap which is very similar to the white variety except for the color of the grain.

Pearl pop corn comprises a group of varieties whose commercial importance is less and whose production is less centralized than that of the two already mentioned. Queen Golden, or Golden Queen, a large yellow variety, is probably the most important of these. The plants are large and vigorous and produce good yields, but require a longer growing season than White Rice or Jap to mature. The popping expansion is only fair and the quality of the popped product not of the best. It is grown to a considerable extent in the southern part of the Corn Belt, where the rice types do not thrive. South American, known also as Dynamite, South African, and by a number of other names, is a variety of the yellow pearl type devel-

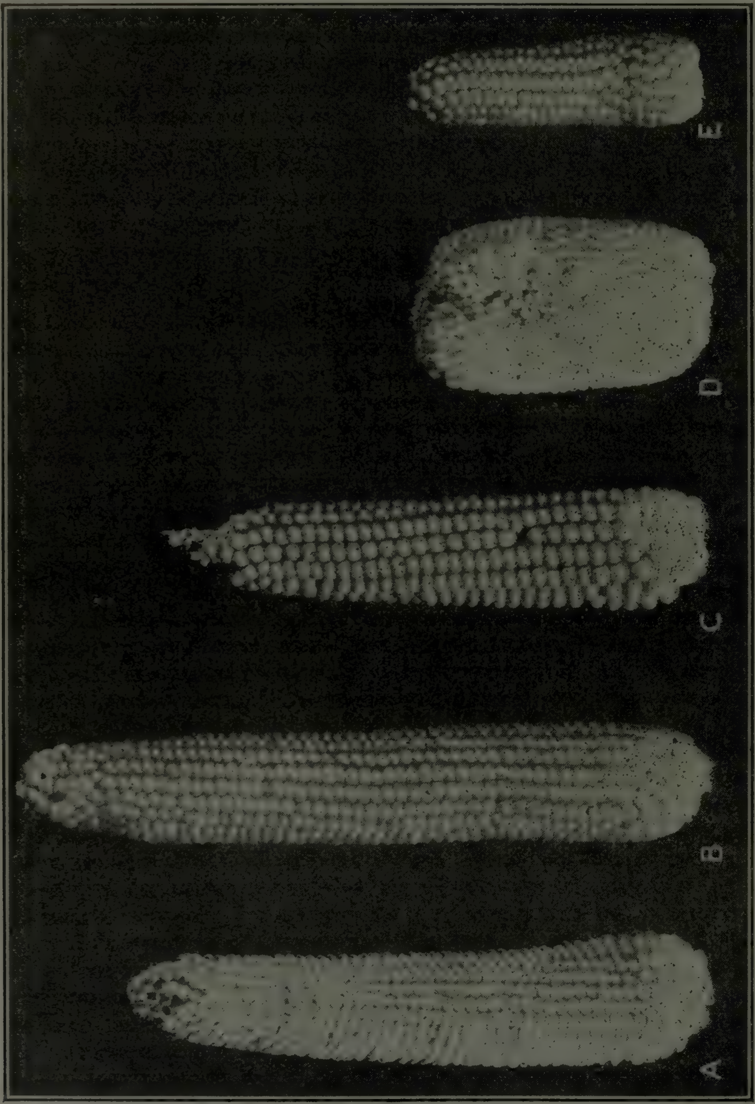


FIGURE 2.—Ears of five varieties of pop corn: A, White Rice; B, Queen Golden; C, South American; D, Jap or Hull-less; E, Tom Thumb

oped during the last few years in the Kansas City territory from a somewhat obscure origin. The original seed was supposed to have been imported from Argentina. The plants are of about the same maturity as Queen Golden, but have fewer suckers and produce smaller yields, especially under adverse conditions. The ears tend

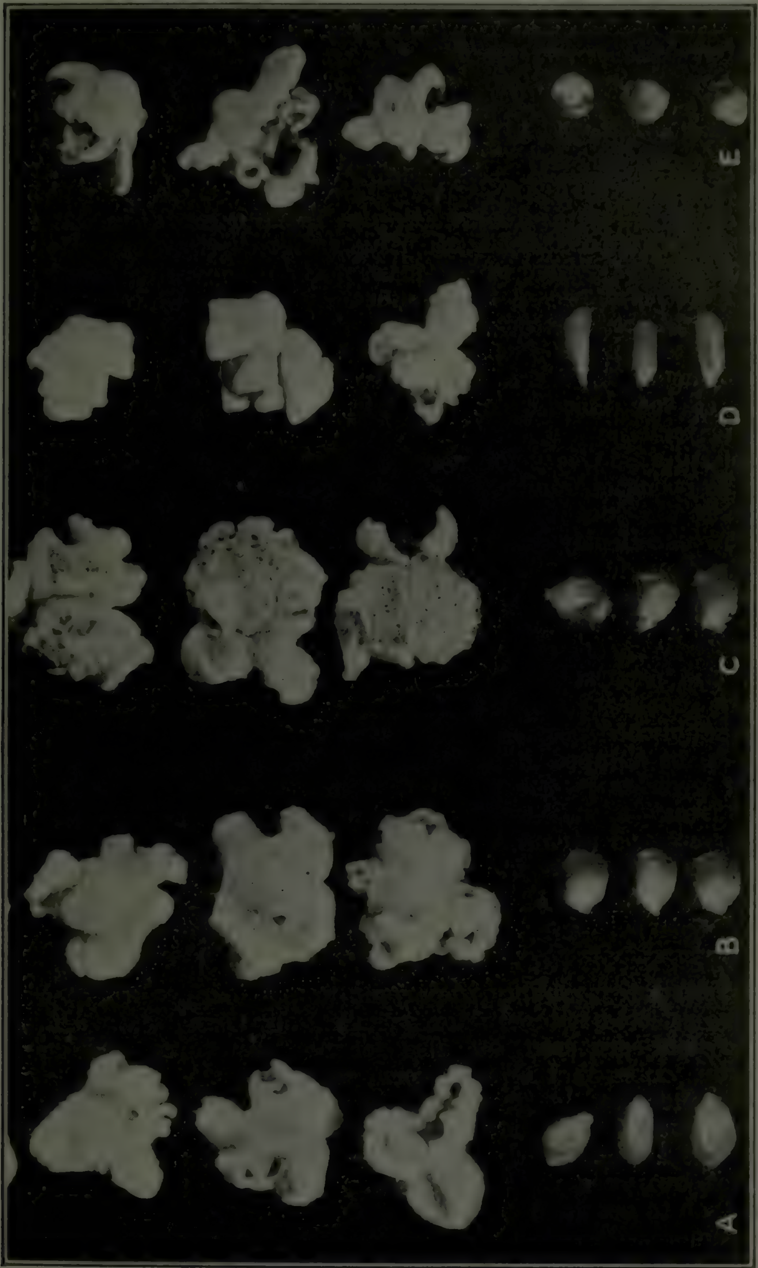


FIGURE 3.—Popped and unpopped kernels of five varieties of pop corn: A, White Rice; B, Queen Golden; C, South American; D, Jap or Hull-less; E, Tom Thumb

to be shorter and have fewer rows than Queen Golden. Very characteristic of the variety are the large kernels with a dull lusterless appearance, and the tendency of the ears to be poorly filled at the butts. This variety has a good popping expansion and produces unusually large, round, popped kernels of a characteristic mottled yellow appearance, but has somewhat tough hulls and woody texture. It is retailed in packages and cans under a number of trade names. Eight Row or Spanish is a white pearl pop corn with few rows and unusually wide kernels. The plants are very small, and the growing season is shorter than for Jap or White Rice. Its main virtue is the large size of the popped kernels which make it useful in the manufacture of pop corn confections. This variety is grown mainly along the northwestern fringe of the main pop corn growing area and in the irrigated valleys of the mountain region. White Pearl is a vigorous productive variety, but its low popping expansion and poor quality make it of little value. Tom Thumb, with its miniature ears, 1½ to 2 inches long, is a curiosity of little commercial importance because of the difficulty of harvesting. It is one of the earliest maturing varieties.

In choosing a variety for commercial production, two main points should be borne in mind. First, the variety selected should be well adapted to the locality where it is to be grown. White Rice and Jap grow excellently in northern Iowa and Nebraska, but can not stand the drought and heat 300 miles south nearly as well as Queen Golden. On the other hand, Queen Golden is too late a variety to mature properly in the region where White Rice and Jap are at their best. Second, a variety should be chosen which can be marketed readily and profitably. If the corn is to be sold locally the type should be grown for which there is a demand or for which a demand can be established because of the excellence of the variety. If the corn is to be shipped it is usually wise to raise the same variety as other growers in the community unless the crop is contracted for in advance or unless special selling arrangements can be made. Local buyers and agents of the large pop-corn companies prefer to handle a single variety in a given region so that it may be shipped and marketed in carload lots.

SEED SELECTION

Seed selection is doubly important in pop corn. Pop-corn seed should be selected not only for germination, vigor, and yield, similarly to field-corn seed, but also for popping volume, tenderness, and flavor. Like that of field corn, the adaptation of pop corn is gradually increased by growing it in a given locality over a period of years through the agency of natural selection, which tends to weed out the less adapted variations. It is usually better, therefore, to raise one's own seed year after year or to obtain it from a near-by grower than to get unadapted seed from a distance.

In common with field-corn seed, pop-corn seed should be selected in the field in the fall before the first hard freeze. Take ears only from sturdy, erect stalks which are productive under competition; that is, which bear good ears under conditions of a full stand. Prematurely ripened, diseased, or broken plants should be avoided.

Attention should also be given to adequate husk protection of the ear and the height on the stalk at which the ear is borne. Two or three times as many ears should be gathered as will be needed for planting, to allow for a liberal culling on the basis of germination and of ear and kernel characters. It is of the utmost importance that these ears be quickly and thoroughly dried before sacking or shelling, to insure maximum vigor and germination. Wire hangers, string hangers, lath frames, or any means that will allow the ears to hang without touching one another in a dry, well-ventilated room or shed are satisfactory.

Pop-corn seed carefully handled will germinate well. It is better, however, not to guess on this point, but to test the germination of the seed before planting. The germination can be tested by any of the ordinary methods. One convenient method is the "rag doll," which is described in Farmers' Bulletin 948, a copy of which may be obtained by writing to the United States Department of Agriculture, Washington, D. C.

If a high-grade product is to be maintained, or improvement made, attention should also be paid to the popping quality. Repeated tests have shown that there is a remarkable variability in the popping expansion of individual ears of a variety when they are tested separately. Of 500 random ears taken from a field, the best ones will usually give twice the popping volume of the poorest ears.

It is, of course, impossible for the average grower to ear test individually all his seed by popping. If, however, a few kernels from each ear are split lengthwise with a sharp knife, the kernels of some ears will be found to have much less soft white starch in the center than those of other ears. These ears with least soft starch in the kernels usually will be the ones with the larger popping expansion and therefore most desirable as seed. In addition to the ears with starchy-centered kernels, ears that show evidences of disease or that are badly off type should also be discarded.

SOILS, ROTATIONS, AND FERTILIZERS [2]

Pop corn may be grown on any soil that will grow good field corn. Pop-corn production should be restricted in general, however, to the more fertile soils that are not too light and sandy. There it will have opportunity to mature fully and produce a high-grade product.

Crop rotation is even more important where pop corn is grown regularly than it is in field-corn production. The smaller pop-corn plants do not shade out the late weeds, so that pop-corn land soon becomes foul unless rotated. Moreover, land continuously in pop corn becomes less productive and infested with insects and diseases. All of these conditions tend not only to reduce yields but also to increase lodging and to lower the quality of the crop. The exact rotation will differ under different conditions. Probably one of the most important items, however, is a legume such as sweet clover or red clover preceding the corn crop. Corn followed by oats seeded with sweetclover which is plowed up just before corn planting the following spring is considered a good rotation. Another rotation frequently followed to advantage is corn, corn, oats, and red clover.

---

[2] The best rotation and the best fertilizer for pop corn depend so largely upon local conditions that discussion here is of necessity very general. The rotations and fertilizers recommended for field-corn production by the different State agricultural experiment stations are suited also for pop-corn production.

Although mineral fertilizers can not take the place of rotations, there is a growing tendency to supplement manure and green manures with commercial fertilizers, particularly superphosphate. One of the principal advantages of a phosphate fertilizer is to hasten development and maturity. Superphosphate may be applied with a fertilizer attachment on the corn planter at the rate of 75 to 150 pounds per acre, or it may be broadcast on the field at the rate of 200 to 300 pounds per acre and worked in before planting. In general, smaller quantities applied in the hill will be as efficient as larger quantities broadcast.

On thin land where the available nitrogen is likely to be low, it often is more desirable to use a complete fertilizer containing nitrogen and some potash in addition to phosphate. Under such conditions a fertilizer containing 4 to 6 per cent of nitrogen, 12 to 16 per cent of phosphoric acid, and possibly also 4 to 6 per cent of potash may be used instead of superphosphate. A fertilizer approximating 4–12–4 used at the rates given above should be sufficient except for the poorest soils. When moisture is likely to be lacking the smaller quantities should be used. Results indicate that mineral fertilizers are not advisable in regions where the average annual rainfall is less than 30 inches, unless the crop is to be irrigated.

PLANTING AND CULTIVATING

The usual methods of successful field-corn culture apply also to pop corn with but slight modifications. In the western part of the Corn Belt, particularly in Nebraska and Kansas, where listing is the common method of growing field corn, pop corn also usually is listed. A practice growing in favor in this section is to blank list in the fall, throw in the ridges about two weeks before planting, and at planting time nose out the old furrows with a loose ground lister or with a furrow-opener attachment on the corn planter. (Fig. 4.) The double advantage thus is obtained of killing two crops of early weeds cheaply and of providing a warmer and mellower seed bed than would be available if the ground were freshly listed.

On plowed land pop corn is usually checkrowed (fig. 5) in order to provide for better cultivation. The rows, especially for the smaller varieties, should be somewhat closer together than for field corn. It is a common practice to have the hills 38 to 40 inches apart each way, and frequently rows as close as 36 inches are used. The rate of planting depends on the variety, the character of the soil, the normal rainfall, and other conditions. In general, the optimum rate will provide for from one and one-fourth to two times as many plants per acre as field corn should have in the same locality. In general, from 5 to 6 pounds of seed are required to plant an acre, although this will vary with the size of seed and the rate of planting.

Special plates for planting pop corn can be obtained from most planter manufacturers, or blank plates may be drilled to meet the special requirements of seed size.

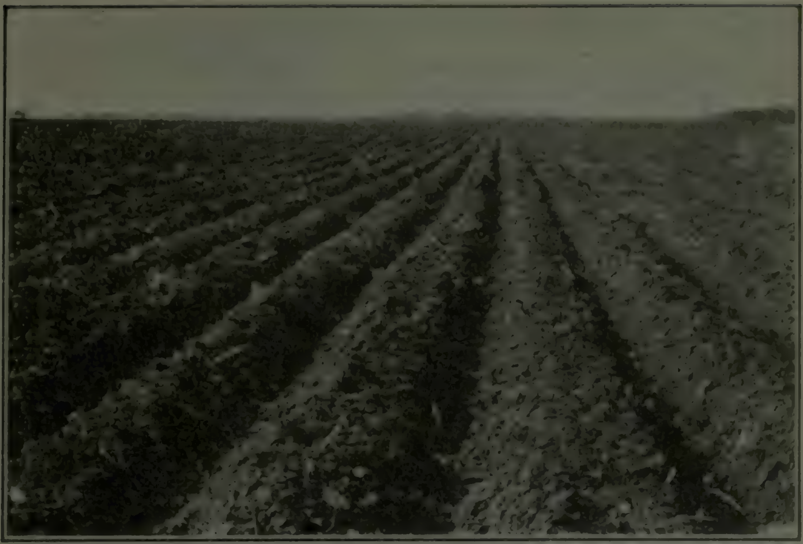


FIGURE 4.—Unplowed field planted with a lister. Unless the ridges are first thrown in and then nosed out, the seed bed frequently will be cold and cloddy

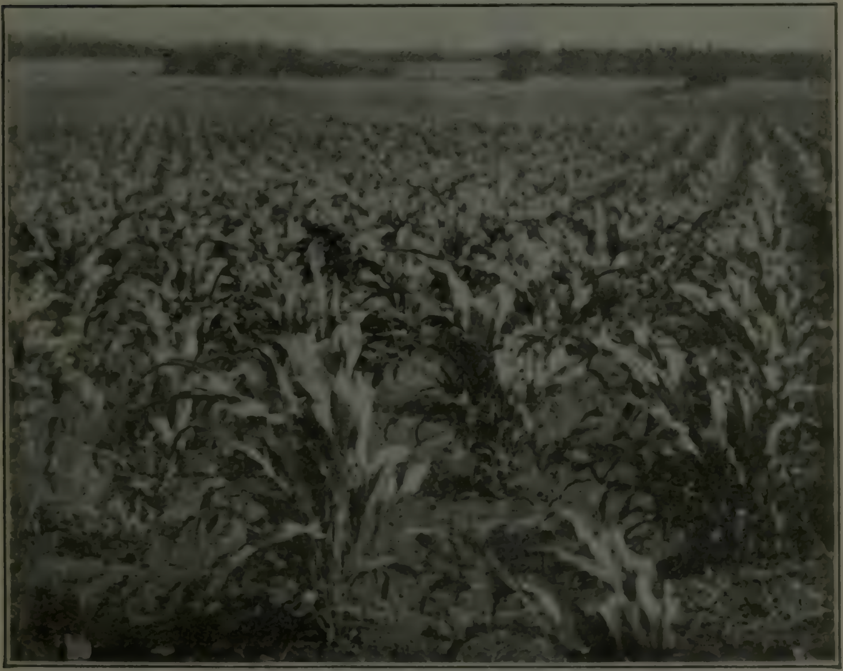


FIGURE 5.—Pop corn planted in checkrows

Corn planters fitted with disk furrow openers (fig. 6) are excellent for planting pop corn on plowed ground. The pop-corn seedlings are small and grow slowly to a size suitable for cultivation. Planting with furrow openers allows the early weeds to be killed with a harrow cheaply and without injuring the small corn plants.

Pop corn may be planted somewhat earlier than field corn, as the hard, vitreous seed is not so easily damaged if the weather happens to turn cold and wet. Early planting is recommended in most localities in order to insure ample time for the crop to mature normally and thoroughly.

The primary purpose of cultivating corn is to control weeds. As has been pointed out, both the yield and quality of pop corn are especially affected by weed growth. The smaller stalks of pop corn can not compete as well with weeds as can those of field corn. The three principal practices which help to control weeds are (1) suitable rotations, (2) early and careful preparation of the ground, and (3) thorough cultivation.

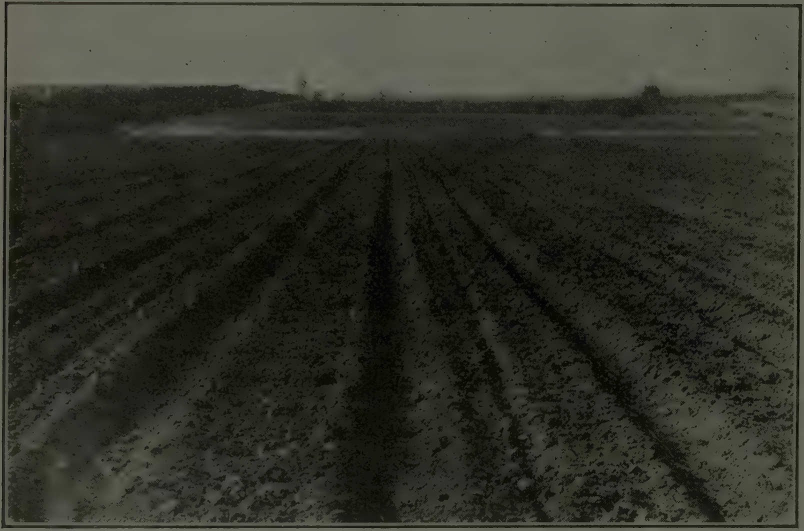


FIGURE 6.—Plowed field planted with a furrow-opener attachment on the planter. Note the opportunity for killing weeds with a harrow without injuring the young corn plants

Weeds can be killed most cheaply when the field is being prepared for planting. Early working encourages germination of weed seeds and allows them to be killed previously to planting. Nearly as effective and inexpensive are the cultivations given the young corn with harrows, weeders, and similar implements, if they are given frequently enough to prevent the small weeds from becoming established.

Later cultivations can be made satisfactorily with any of the usual cultivators. Cultivations should be frequent enough to control weeds, depending upon the nature of the season. In general, cultivations, particularly the later ones, should be shallow so as not to injure the corn roots unnecessarily. Occasionally, however, it may be desirable to cultivate deeper. Thus, on heavier soils after a beating rain it is frequently profitable to go deep in the first cultivation and loosen the soil.

HARVESTING

Harvesting is one of the most tedious parts of pop-corn production if hand labor is used. (Fig. 7.) Many huskers get so discouraged the first day or two that they refuse to husk pop corn even though the rate per bushel is enough greater than that for field corn so that they receive as much per day as for field corn. Jap corn usually is snapped rather than husked.

During the last few years the improvement of mechanical pickers has made them increasingly popular for pop corn. (Fig. 8.) In some localities of commercial production 75 per cent or more of the pop corn now is harvested with pickers, the farmers with machines frequently doing considerable custom work for neighbors. Several makes of machines are giving satisfactory service. Most of them are of the single-row type, although a few 2-row pickers also are in use. The first cost of these machines is rather high, ranging from $300 to $700, but if the owner and his neighbors can furnish sufficient acreage to keep the picker busy, the cost per bushel should be less than for hand husking.

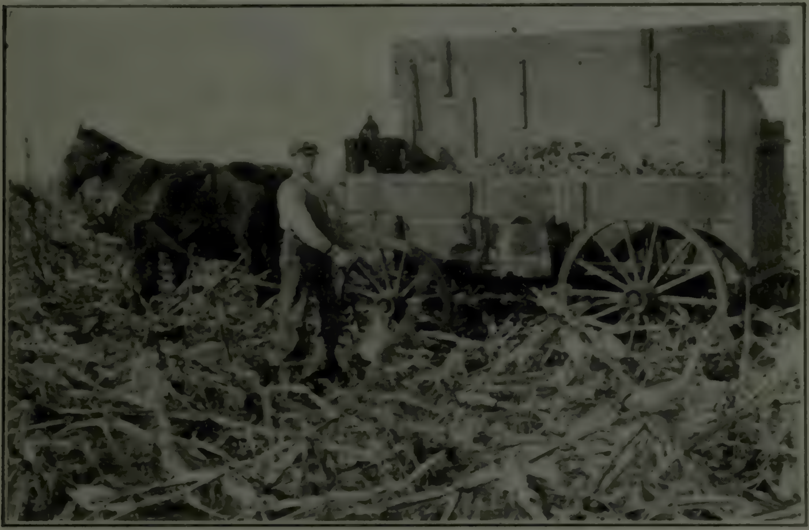


FIGURE 7.—Husking pop corn by hand. The small box on the side of the wagon is for unusually fine ears to be saved for seed

An important advantage of the picker is the fact that the crop can be harvested quickly before it deteriorates by weathering. Pickers will frequently leave 200 to 300 pounds in the field where corn is badly down; but where it is standing well a good picker should not leave more than 50 pounds to the acre. Little trouble ordinarily is experienced in shelling when the stalks are dry and brittle.

STORING

Pop corn seldom is dry enough to pop well when harvested. Cribs must provide adequate ventilation to cure the corn to optimum moisture content before shelling. As pop corn is used as a human food, special precautions also should be taken to prevent damage during storage by rats and mice and by heating. (Fig. 9.)

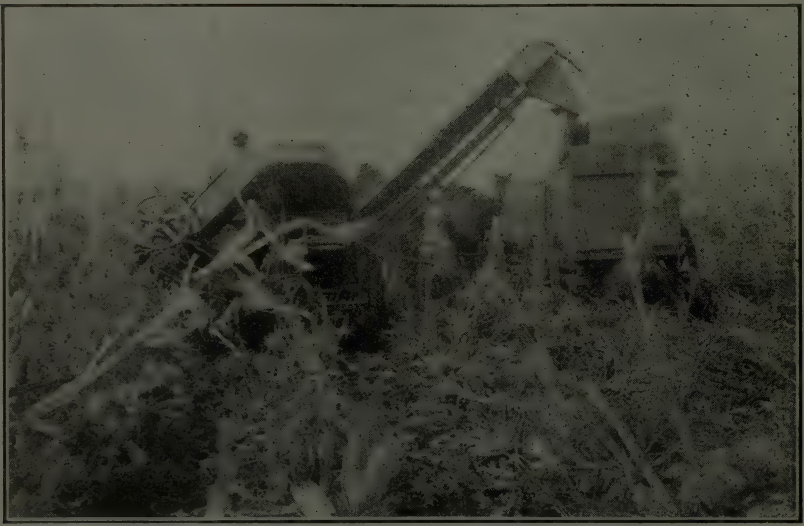


FIGURE 8.—Husking pop corn with a mechanical picker

The precautions necessary in a given locality will depend upon the usual moisture content of the corn at harvest and upon the weather which usually follows harvest. In Iowa, for example, the crop almost always contains considerable excess moisture when husked, and the succeeding months are so unfavorable for drying that it does not reach a good popping condition until the following May or June. Here, cribs constructed to allow unusually good ventilation are the rule. Crib widths of 4 feet ordinarily are considered satisfactory

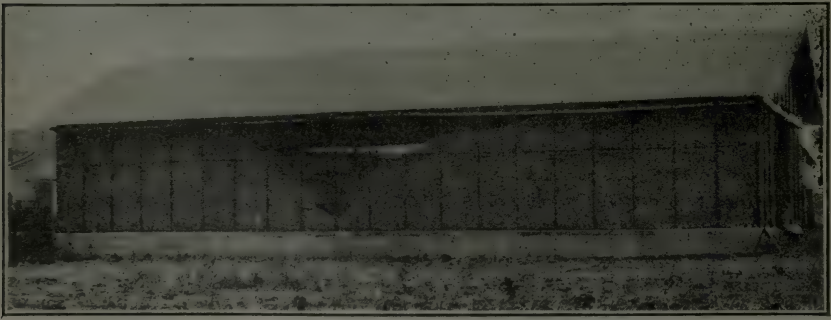


FIGURE 9.—A rat and mouse proof crib having a concrete foundation, an iron frame with wire netting, and storm curtains on the sides and at the ends

under these conditions. If wider cribs are used, temporary partitions or air tunnels frequently are added, as shown in Figure 10, to provide the ventilation needed for proper curing. The storage cribs of the large pop-corn companies in centers of commercial production are models of satisfactory design and sound construction.

In Kansas, on the other hand, early planted pop corn usually is well cured when husked. In addition, the autumns are comparatively late and dry, so that corn frequently is in popping condition by Thanksgiving Day. As a result of these factors, much less attention to pop-corn storage is necessary in order to produce a well-cured product.

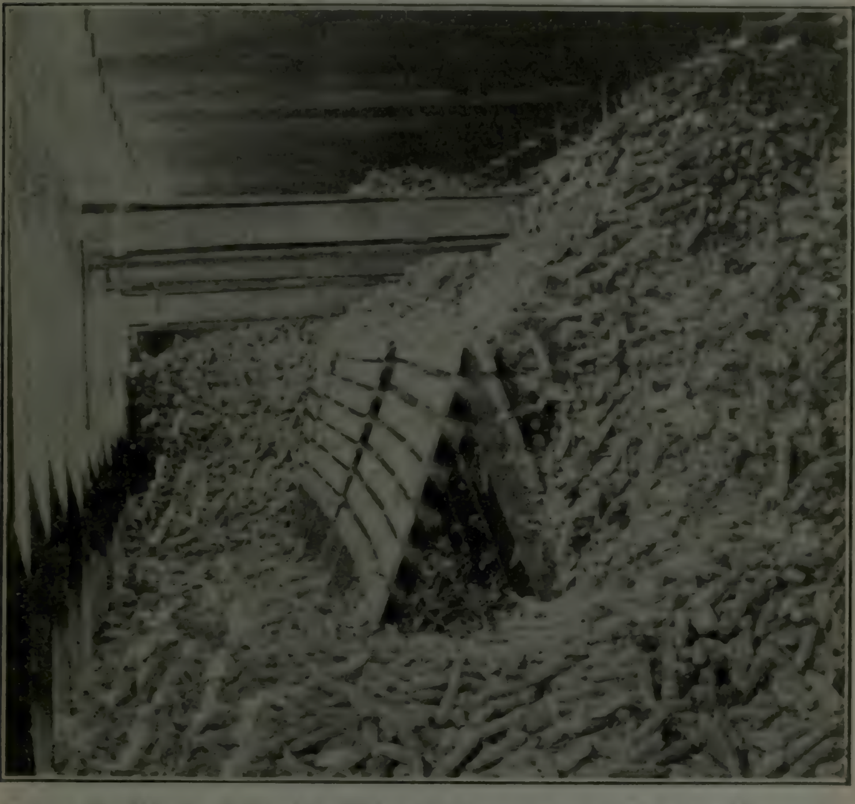


FIGURE 10.—Movable A-shaped ventilators in a pop-corn crib. These should extend the entire length of the crib to provide a free circulation of air

Pop corn should not be shelled until it has reached the optimum moisture content for popping (about 13 to 14 per cent). Moreover, dealers prefer not to shell until very shortly before the corn is to be used because of the greater danger of the shelled corn going out of condition. As a result, practically all bulk pop corn is stored and shipped on the ear. (Fig. 11.) If protected from insects and rodents, ear corn may be stored three or four years without apparent deterioration in popping quality.

MARKETING

As is the case with most specialized crops, marketing is an important factor in determining whether or not pop corn is to return a profit. Three main outlets are open and will be discussed separately; namely, local sales, contracted acreage, and selling on the open market.

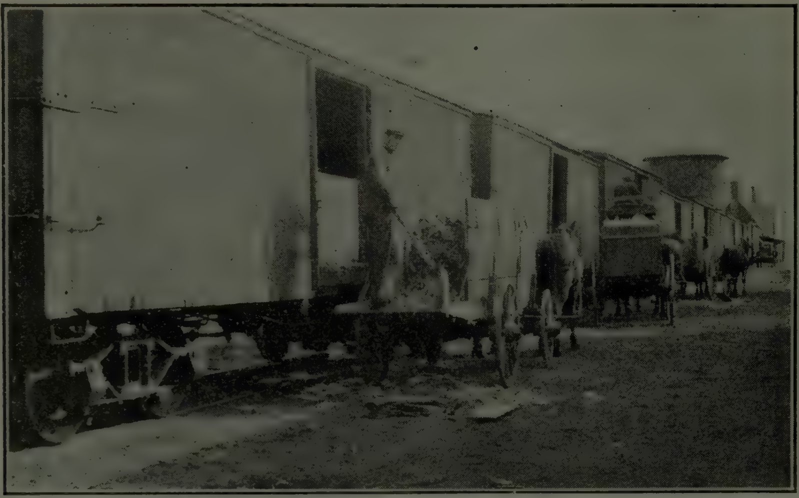


FIGURE 11.—Loading pop corn for shipment

Local or specialized sales may be utilized particularly well by those growers who live near cities and where little pop corn is raised. A product of high and uniform quality with a little judicious advertising frequently will find a ready market in a near-by city. It may even stimulate the pop-corn consumption and so develop a larger demand. One grower in Oregon, who has built up a reputation for quality, retails his entire crop each year to cus-

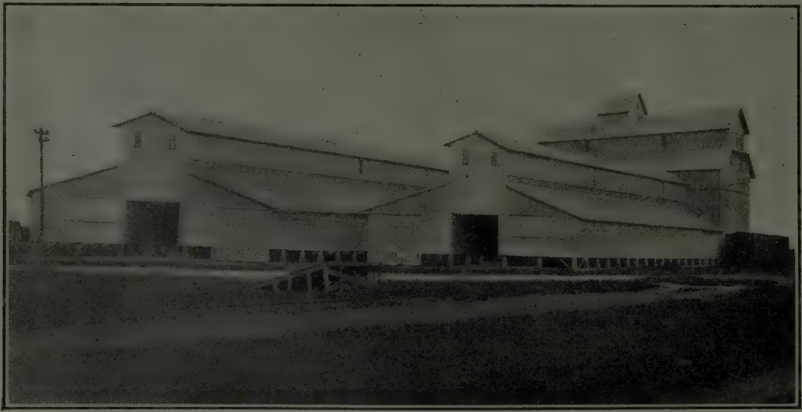


FIGURE 12.—Pop-corn elevator and storage cribs in Nebraska

tomers who call for it at the farm. Essentials for success in making local sales include (1) a high-quality variety, (2) proper moisture content, (3) sorting out diseased and moldy ears before shelling, (4) careful shelling and cleaning, and (5) clean, attractive sacks or packages. Too frequently growers are careless about one or more of the above points, so that retail customers of direct sales are not fully satisfied.

Much of the commercial pop-corn acreage is always contracted for in advance by the large pop-corn companies and seed houses. This tends to stabilize the market and to guarantee a reasonable profit to both grower and jobber. The contract usually calls for the entire crop to be delivered in the ear to some designated crib or elevator (fig. 12) at a fixed price per pound. The seed from which the crop is to be grown generally is furnished by the company as part of the contract.

The grower who does not contract his crop in advance assumes the risks of fluctuations in price. If the crop happens to be short or if demand increases, bringing higher prices, he may make a substantial profit. On the other hand, if a considerable surplus is in sight at harvest time, the free-lance grower will find buyers very indifferent about taking noncontracted corn, with sales at distress prices the only outlet, if he is forced to sell.

The pop-corn acreage can be expanded very easily to an extent where production becomes unprofitable. Only a year or two of relatively high pop-corn prices or of relatively low field-corn prices, or both, will cause the regular growers to increase their acreage. In addition, a host of new growers are added, attracted by stories of the large profits of their friends and neighbors. The results are overproduction, low prices, and losses.

The large pop-corn companies keep in close touch with the current acreage and condition of the crop, as well as with the probable market demand and amount of carry-over, and regulate their prices for cash corn and their bids for contracted acreage accordingly. By keeping informed on fluctuations in current cash prices, and particularly on the prices for the product of acreages contracted for the coming season, the small grower can keep somewhat in touch with market conditions and make his plans accordingly. It is usually unwise, especially for the amateur pop-corn grower, to plant a large acreage immediately following a year of high prices. The chances are that many others will do the same thing, with the result that the market will be flooded and that there will be a disastrous drop in prices.

Pop corn differs greatly in its popping expansion; that is, the volume ratio of the popped to the unpopped corn. For instance, if a cup full of corn will pop out 17 cups full, it is said to have an expansion of 17 volumes. Glass graduates containing two popped and unpopped samples illustrating a difference in expansibility are shown in Figure 13. Unfortunately, a method for making the test has never been thoroughly standardized, and there is frequently a disagreement between two tests, due to the size and shape of the measures, the degree to which the popped sample is packed before the reading is taken, etc.

Popping expansion is influenced by the innate excellence of the variety or strain, its opportunity for complete and normal maturity, and the moisture content of the corn at the time of popping. There are no standard grades, but in general, for bulk samples of retail corn, expansions of under 15 volumes may be considered poor, those of 15 to 19 volumes fair, those of 20 to 24 volumes good, and those of 25 or more volumes excellent. Although expansion usually is considered in marketing pop corn, it should be given even more weight in determining price. Some system of premiums for high-popping samples similar to the premiums paid for high-protein wheat could easily be worked out. The bulk of the popped corn, the end product,

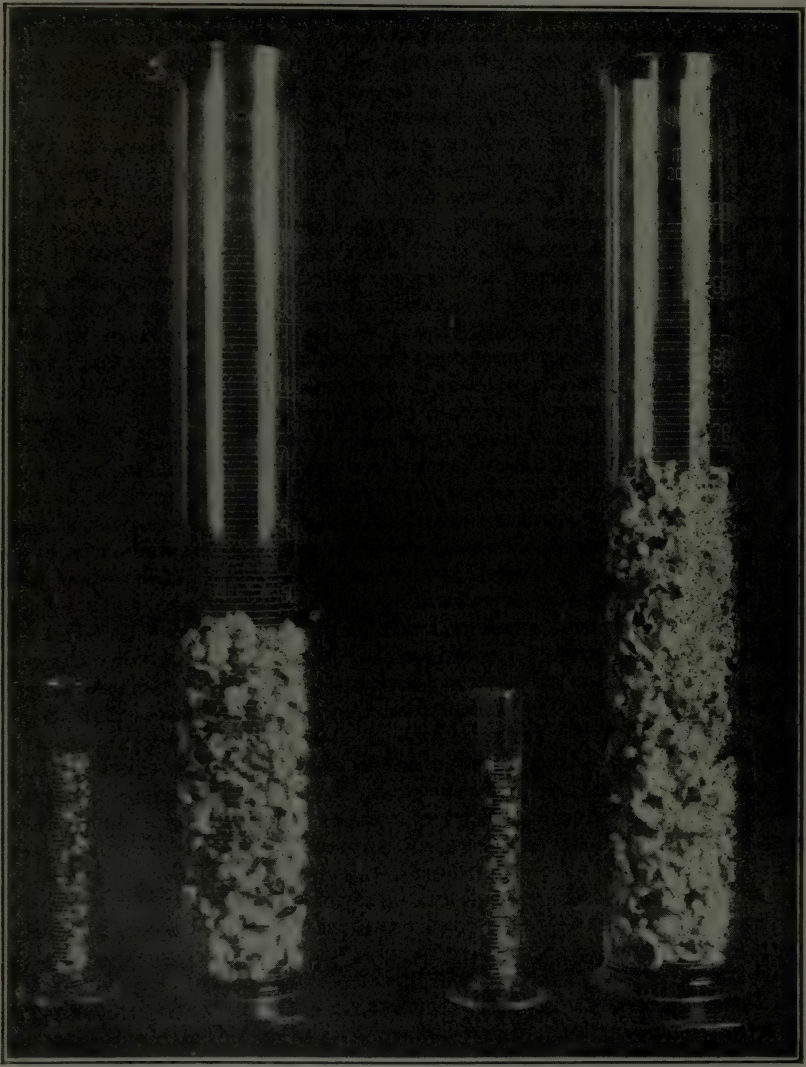


FIGURE 13.—Two samples of pop corn before and after popping, showing differences in expansibility

varies with the expansion. Even more important, the tenderness and quality of the best popping corns usually are superior, making a double advantage for the samples with high expansion.

INSECTS AND DISEASES

The insects and diseases that injure field corn also attack pop corn. The more important insects attacking pop corn in the field are corn earworms, cutworms, army worms, rootworms, and the like. The grain weevil and the Angoumois grain moth are the more important pests of stored pop corn, and in the Southern States they may cause damage before the ears are harvested. Crop rotation and clean farming will help in reducing the amount of infestation and damage by many of the field insects. Specific measures for reducing damage by others are given in bulletins which may be had upon application to the United States Department of Agriculture.

It should be pointed out, however, that damage to the grain such as that caused by the corn earworm, the weevils, and the grain moth is more serious in pop corn because of its use for human food. Except for local markets, areas where such damage is usual and severe can not hope to compete in pop-corn production with areas where such damage is negligible.

The more important diseases affecting pop corn are smut and the root, stalk, and ear rots. Selecting seed from disease-free stalks will promote the development of strains more or less resistant to diseases. Special selection of seed on the basis of germination tests should be used in areas where the various rot diseases are prevalent.[3] Because of hard endosperm pop corn is not as susceptible to these diseases as dent corn. However, injury is more serious when it occurs, because it reduces the quality of the corn and in pop corn quality is of greater importance.

DOES IT PAY TO GROW POP CORN?

The frequently asked question, "Does it pay to grow pop corn?" can not be answered simply by "yes" or "no." The demand for pop corn is rather constant, and the supply usually just about meets this demand at a reasonable profit to the producer. Any material increase in supply tends to decrease the price to a level where production is unprofitable. In areas of regular commercial production pop corn probably pays the successful grower about as well as or a little better than field corn. In areas where pop corn is not produced regularly in commercial quantities the difficulties of marketing advantageously reduce the chances of profitable production.

Profit in producing pop corn on a smaller scale to meet local demand depends upon the ability of the individual as a merchant as well as upon his ability as a producer. He must, of course, produce a crop of good quality economically. The development of direct sales in competition with others, however, will depend largely upon the care with which the product is first stored and then prepared for market so that it will retain its quality and be attractive.

---

[3] See Farmers' Bulletin 1176, Control of the Root, Stalk, and Ear Rot Diseases of Corn.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	ARTHUR M. HYDE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	W. G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel and Business Administration.	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Solicitor	E. L. MARSHALL.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	R. Y. STUART, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Plant Quarantine and Control Administration	LEE A. STRONG, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	J. T. JARDINE, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*

U. S. GOVERNMENT PRINTING OFFICE: 1931

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1680

FARMERS IN NORTHERN STATES GROW TIMBER AS MONEY CROP

1862 1889

THERE IS A GROWING interest among farmers in the better handling of the woodland and in making that part of the farm produce its proportionate share of income. With this increased interest, many questions arise concerning better practices in growing timber crops. Actual experiences will undoubtedly throw considerable light on these problems and may stimulate others to put their idle acres to work growing trees. With this in view a number of rather conservative examples of timber growing have been brought together here.

Some of these examples have been obtained directly from farmers, but most of them were contributed by extension foresters of the Northern States who have demonstrated better methods in the growing of crops of timber to thousands of woodland owners. Should further information be desired concerning any of the examples, it is suggested that the request be directed to the local county agricultural agent or to the State extension forester located at the State college of agriculture. Should assistance in local farm-woodland problems be desired, it is suggested that correspondence be directed to the same agencies, or to the State forestry department, or to the Forest Service, United States Department of Agriculture.

Washington, D. C. Issued December, 1931

FARMERS IN NORTHERN STATES GROW TIMBER AS MONEY CROP

By W. K. WILLIAMS, *Extension Forester, Office of Cooperative Extension Work*[1]

CONTENTS

	Page
Value of practical timber-growing examples	1
Farmer draws on timber bank	3
An Indiana farm-woodland success	4
Thinning proved of great value on a Pennsylvania farm	4
An Iowa farm wood lot pays its way	5
Farm woods show substantial profit over a 17-year period	6
Dairy farmer answers timber question	8
Changes cutting tactics—finds woods farming pays	8
Farmer develops paying timber plan	11
The farm woods provide timber for a barn	13
Farm woods yield third crop of construction timber	15
Farmer tells story of his woods	15
Farming the woods	16
Timber pays farmer over long period	16
Farmer handles timber as a crop	17
More dollars than expected	18
Cash income of $5.83 an acre yearly	18
Home-grown lumber and fuel pay interest on investment	19
Finds timberland profitable—buys more	21

VALUE OF PRACTICAL TIMBER-GROWING EXAMPLES

Examples of success in growing trees for the actual cash return are especially valuable when they come direct from experienced farmers who have spent many hours in the woods thinking, planning, and working. They offer helpful suggestions in planning a timber-growing program and inspire greater interest in the value, use, and protection of this farm resource.

In timber growing it must be remembered that, although profits may not be large in all cases, the increased return in wood products for farm use or a greater cash return from the sale of products will add a degree of stability to the farm balance sheet and perhaps transform a farm liability into an asset.

Farmers who have promoted far-sighted programs by growing wood crops are reaping rewards. Their farms are more attractive and valuable, and their families are enjoying pleasures and benefits which only trees can contribute to farm life.

Remarks of those who have engaged in the business of farm timber growing are interesting and suggestive. A Pennsylvania farmer after five years of woods farming said:

> Farm your woods as you do a crop of corn. Take out the weed trees and the unhealthy and crippled ones and give the best trees a chance to develop and ripen. Cut the good trees only when they are ripe.

An Ohio farmer said that he used the woods to fall back on when times became hard, and commented further:

> Money from the sale of timber has helped to pay for the farm, take care of taxes, and assist in giving the children a good education, and in addition has furnished lumber, posts, and fuel for the farm.

---

[1] Special acknowledgment is made of the assistance of the following extension foresters who have each contributed several examples from their respective States: I. T. Bode, of Iowa; Forrest W. Dean, of Ohio; J. A. Cope, of New York; and F. T. Murphey, of Pennsylvania. The assistance of Forest Service officers, and particularly the suggestions made by W. R. Mattoon, extension forester, also have contributed much to the publication.

Many other such statements could be given, pointing out the compensations to be received from growing trees as a money crop.

MAKE FARM WOODS PRODUCTIVE

Most farms in the Northern States have small woodlands located on hillsides, along streams, or on the rougher and poorer areas. On some farms these areas are kept in a productive condition; on others, wood production has been reduced to practically nothing, because of neglect. Every dollar of loss through holding idle woodlands is a direct drain on the farmer's yearly income and a factor which retards better living standards. It is good farm business to see that these loafing acres are turned into money-makers.

Timber can be raised as a crop like any other farm crop, the only difference being that a longer period of years is required for the timber crop to reach maturity. With trees of many different ages and sizes in the farm woods, however, the owner need not experience much delay in reaping the advantages of a timber crop. Many farmers have woodlands containing good stands of young trees which, if given protection and cut rightly, can be made to produce successive harvests of wood products.

The chief aim in growing timber is to make a profit. Farmers who have given attention to their woods in many cases have expressed surprise at the returns. Even if the farmer sells no timber, a good woodland will often pay by furnishing firewood, fence posts, poles, and material for repair and construction of farm buildings.

TIMBER CROPS REQUIRE BUSINESS METHODS

The rewards from the farm woods do not just happen but are the result of foresight, planning, and work. Profitable timber growing requires the business methods needed in the successful production of other farm crops. It will be noted in the examples given that the owners in cutting their timber took the more mature trees and the inferior ones, leaving the smaller thrifty trees and young growth. This method protects the owner's investment, and other crops of timber can be expected. Farm woods handled according to the best practices should yield a fair return on the investment and also provide wages for labor. These factors are brought out in a practical manner in the story entitled "Farm Woods Show Subsantial Profits Over a 17-Year Period." As is true in this case, it is always advisable to keep records of time, costs, and returns in farm-timber operations. If a cash return for the timber can be shown after deducting interest, labor costs, and other carrying charges, timber growing is placed in a much stronger position as a farm business, and the investment is fully justified. Good farm management calls for making all farm areas, including the woodlands, profitable farm units.

PLANNING NEEDED FOR SUCCESSFUL TIMBER CROPS

Better planning is needed to put farm woodlands on a more productive basis and on an equality with other cropping areas. This means better planned growing and cutting operations and closer contact with local markets in merchandising timber products of better quality and workmanship. The farmer should know how much standing timber he has, his own needs about the farm, and how to cut out the ripe and the inferior trees without injuring the younger ones. Also he should know the value of the timber and the available markets, and then provide time in his farm program to harvest his timber with his own labor and teams. If this program is developed according to a plan that will provide paying crops at fairly regular intervals, it can be said that wood is being produced as a money crop.

A Connecticut farmer named the principal elements of a timber-growing program when he said:

> There are only three things required of any man to preserve his wood and timber for his own use and for the next generation. They are simply common sense, a sharp ax, and a thought for the future.

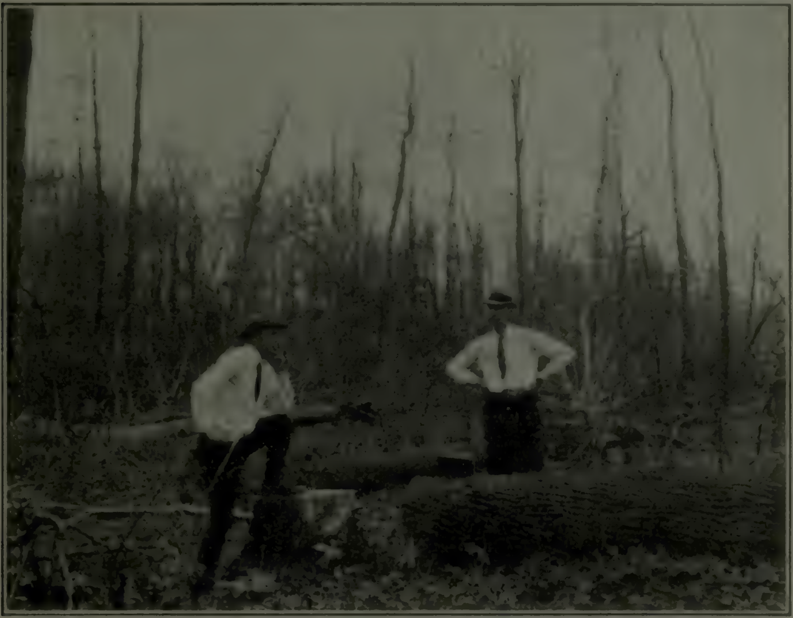


FIGURE 1.—Only the ripe trees are cut, according to the Wilcox plan, and the woods are protected from fire and grazing

FARMER DRAWS ON TIMBER BANK

That the farm woods are as good as a savings-bank account is clearly seen in the case of the farm of C. N. Wilcox, North Fairfield, Huron County, Ohio. Since 1910, when Mr. Wilcox took possession of the farm, the woodland comprising about 20 acres has come in handy "as to fall back upon,"—his own words—when times became hard on the farm. Money received from the sale of timber has helped to pay for the farm, to pay taxes, to give his children a good education, and in addition, to furnish lumber, posts, and fuel for the farm. (Fig. 1.)

When Mr. Wilcox, just starting out as a young farmer, took possession of the farm 20 years ago, he was advised to sell off all the timber. To-day he is more than glad that he did not. During the last 10 years these farm woods have given him nearly $1,000 in returns from saw logs. He still has an excellent stand of young timber, growing rapidly into a new crop of salable timber of high quality. Recently he sold several hundred dollars' worth of sugar maple, beech, tulip poplar, white elm, white ash, red oak, and black walnut.

Mr. Wilcox has never pastured his woods, and does not intend to, since grazing destroys the valuable young growth, which later can be converted into ready cash.

Hundreds of fine straight saplings of tulip poplar, ash, red oak, and sugar maple are coming into the openings from which the matured trees were removed a few years ago. This young growth is one of the most encouraging evidences seen anywhere that it pays to protect the farm woods.

AN INDIANA FARM-WOODLAND SUCCESS

For $570 John Fensel, of Montpelier, Ind., bought 20 acres of hardwood forest in 1900, just after all the timber down to 3 inches in diameter had been cut for spokes. Since that time the woodland has supplied the timber for the following buildings: A double corncrib 20 by 24 feet, a sheep barn 20 by 30 feet, a horse barn 20 by 36 feet, a garage 10 by 14 feet, and a cellar house 12 by 14 feet. Not less than 150 posts and 40 cords of wood have been taken from the forest, either to be used on the farm or to be sold. In addition, the ash was sold for handles in 1918 for $400, and the elm was sold for barrels in 1924 for $300. For the standing timber Mr. Fensel has been offered $3,000.

Mr. Fensel has "farmed" his woods, choosing the mature and undesirable trees for cutting, and has protected it from fire. He permitted grazing for one year only. The prolific crop of young growth in his woodland forms a striking contrast to the complete absence of tree seedlings on an adjoining woodland area which has been heavily pastured.

THINNING PROVED OF GREAT VALUE ON A PENNSYLVANIA FARM

One day during the fall of 1927, W. C. Follmer and his son Charles, of Benton, Pa., walked out into their woodland and proceeded to look over 2 acres of timber. Every tree was scrutinized closely and a bark blaze put on all trees which were to be cut.

The particular piece of land chosen for the start of the thinning work possesses a real history. It was first logged immediately following the Civil War, at which time the wonderful virgin growth was cut to help stock the great sawmills of the State. At that time Pennsylvania was second only to Michigan among the lumber-producing States. The piece was logged again just before the beginning of the twentieth century and again in 1912.

Three timber crops had therefore come from the woodland when the Follmers decided that what it needed next was thinning. This involved removal of inferior old trees that had stood through the earlier harvests, as well as the cutting of the poor stuff of smaller growth.

Having made their decision, they turned the job over to two cutters, cautioning them to take out only trees that were marked, unless others were injured by the fall of adjacent trees.

Before the winter was over the originally selected area was increased to 4 acres. After the job was done the thinned parts looked so well that a neighbor said: "Thinning the woods is eating your cake and having it, too."

Now the short, bushy-crowned, crooked, injured, slow-growing trees of poor kinds are gone; the tall, well-crowned, straight, sound, fast-growing trees of the more valuable species are left, and growth conditions have been improved.

Sprags, which are used to brake the wheels of small coal cars when they run too fast on the down grades of mines, were made from most of the timber cut. Nearly 10,000 of these tapered pieces, 22 inches long and 2¼ to 3½ inches at middiameter, were manufactured. (Fig. 2.) The value of these was $170.70. Then, there were logs worth $60; lumber, worth $45; material for crates, worth $24; and fuel wood, worth $24; altogether $323.70 worth of products harvested and prepared for market at a cost of $239.10. This left the Follmers a net profit of $84.60. Since 4 acres were thinned, the net profit amounted to $21.15 an acre. But more than that, the timber stand left is in better condition in every way.

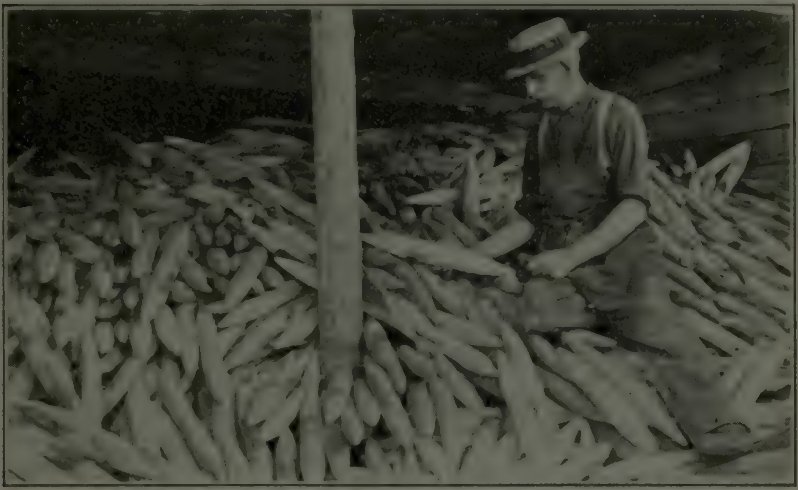


FIGURE 2.—Mr. Follmer inspecting sprags in the storage shed

AN IOWA FARM WOOD LOT PAYS ITS WAY

"A woodland will easily pay for the land it occupies," says S. A. Walker, of Boone County, Iowa. "I have lived on this farm for 17 years and haven't bought 3 tons of coal altogether. We have had plenty of heat, too." Besides the fuel wood which Mr. Walker has used himself, he has furnished his son's winter supply for the last four or five years, and has sawed out some 16,000 board feet of construction lumber.

"When you figure that this wood takes the place of at least a $40 annual coal bill, you can easily see its value," says Mr. Walker.

There are about 2½ acres in Mr. Walker's woods. He has taken from this tract the equivalent of 22 winters' supply of fuel, which he estimates had a total value of $1,100. There are still left enough trees to be taken out in thinnings to supply fuel wood for three or four winters, in addition to the better trees being held for further growth. The remaining fuel wood, worth $150 on the basis Mr. Walker stated, makes a total fuel value of $1,250 for the period he has owned the woods. No figures are available for yields obtained previous to this time.

But fuel wood is not the only product which has come from the farm woods. Mr. Walker has sawed construction lumber from some of the best trees at various times. He said:

> The first time we sawed something over 7,000 board feet of lumber. This was sawed from about 20 trees of 18 to 30 inches diameter, at a total cost of $48, or about $7 per thousand. Another time we sawed about 3,000 board feet, which cost $12 for the sawing. The fellow who did the sawing wanted to buy half the lumber, and when I offered it to him for $10 he snapped it up in a hurry. I have realized since that I didn't get out of that lumber anything near what it was worth.
>
> Last spring we sawed another 6,000 feet from 25 to 30 trees. This cost us $10 a thousand for the sawing, the highest we have had to pay. This lumber has been good construction lumber and has surely been cheaper than buying other lumber.

The lumber which Mr. Walker has sawed is worth $24 to $30 per thousand at least. The value of the lumber, together with the estimate Mr. Walker has made of the value of fuel wood and of the material still in the woodland, give a return of some $1,700 or more during the 17-year period that Mr. Walker has owned the woodland. Even if this return alone is distributed over 40 years, the probable age of the woods, and the costs of lumber sawing deducted, there is left a return of approximately $15.62 per acre per year.

These figures take no account of the value that the farm woodland has had as a protection to the farm buildings and lots.

The remainder of the trees are now nearly mature, and Mr. Walker is making plans to renew his woods systematically.

FARM WOODS SHOW SUBSTANTIAL PROFIT OVER A 17-YEAR PERIOD

The farm woodland owned by D. E. Laucks, of Herkimer County, N. Y., is typical, as far as composition goes, of thousands of acres of farm woods in central New York, consisting as it does of a mixed stand of beech, yellow birch, and hard maple, with some white ash, basswood, elm, and ironwood. The noteworthy thing about this woods is that it has been given careful attention during the last 17 years and that records have been kept for this period on the material removed.

Thirty-one years ago this 11-acre block of woods was cut over by a portable-mill operator who, following the usual practice, cut everything that would make a 2 by 4. A few scattered beech trees, too limby and knotty to be worth felling, were left; otherwise the area was cut clear. In 1912 Mr. Laucks bought the 11 acres of cut-over land for $9 an acre, a total investment of about $100.

In the 13 years that had elapsed since the original cutting, a vigorous stand of sprout growth had sprung up; in fact, it was this young growth that was of particular interest in the investment. As soon as title to the woods passed into Mr. Laucks's hands, he began careful cuttings in the tract to improve growing conditions and to obtain annually the fuel wood required for home use. (Fig. 3.)

For the last 17 years Mr. Laucks has taken out each year from this 11-acre block, 12 standard cords in short-length fuel wood, or a little more than 1 cord per acre per year. His annual cutting during this 17-year period has removed most of the older defective beech and a quantity of the poorly shaped inferior second growth.

A sample area in this woods measured in 1929 showed a mixed hardwood stand made up largely of fine ash, basswood, and hard maple, running around 25 standard cords to the acre. No figures are available on the volume of the stand at the time it was purchased 17 years ago, but it is fair to assume that the volume at that time was probably about 15 standard cords per acre, including the large beech trees.

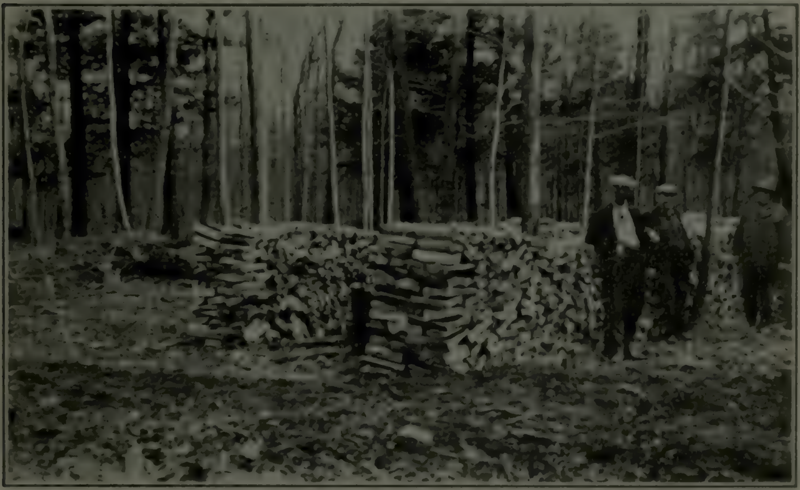


FIGURE 3.—Typical view of a profitable fuel-wood cutting carried on by Mr. Laucks and a number of other New York farmers

On this basis Mr. Laucks's woodland has yielded in fuel wood more than a standard cord of wood per acre per year, and at the same time his forest capital in growing trees has been built up from 15 to 25 cords per acre. It should also be pointed out that this careful cutting has improved the quality as well as the quantity of his forest capital.

The financial aspect of Mr. Laucks's woods work is equally worthy of note. On the basis of actual work done and the sale value of fuel wood in that community, the owner figures that the woodland has yielded $70 in fuel wood per year for 17 years, or a grand total of $1,190.

It should be remembered that this is a net figure; liberal wages for cutting, hauling, and buzzing this wood have already been deducted. If Mr. Laucks had put this $100 in a savings bank paying 4 per cent compound interest it would have amounted to $194.79 in the 17 years.

His total expense on account of this woodland is thus:

Original cost plus interest	$194.79
Annual taxes for 17 years with interest	161.62
Total	356.41
Fuel wood produced, net value	1,190.00
Costs	356.41
Balance in favor of Mr. Laucks	833.59

This profit is on what has been cut. In addition Mr. Laucks has a woodland with a present yield of 25 cords per acre. This is figuring on the basis of fuel wood only. Within the next 20 years some of the 8-inch white ash and the 10-inch basswood will be ready to cut, and will bring a higher return than it would if cut for fuel.

While it is obvious that these substantial returns came about partly because the original owner probably sold his " brush lot " at a reasonable figure, the fact remains that carefully planned cutting will make any well-stocked woodland an income-producing unit of the farm.

DAIRY FARMER ANSWERS TIMBER QUESTION

Is second-growth timber of any use, and is there any money in it? That is the question asked by many farmers. R. C. Damon, of Ashby, Mass., has a satisfactory answer. With about 200 acres of land and a good tract of it in thick second growth of medium size this question gave Mr. Damon considerable concern until he got in touch with the extension workers of the Massachusetts Agricultural College.

During the fall of 1927, the extension forester from the college selected the trees on a quarter of an acre of Mr. Damon's woods for a thinning demonstration. Only about half the trees were marked for cutting, yet they yielded 8¼ cords. Figure 4 shows the improved condition of Mr. Damon's woods.

Cutting, sawing, splitting, and delivering these 8¼ cords cost $68.87. They were delivered to the customers for $12.50 a cord, bringing in a return of $103.12—a net profit of $34.25, or $4.15 per cord.

Mr. Damon believes that with careful thinning and protection his woodlands will produce yearly a cord of wood on every acre and will help to increase his yearly income. In commenting on better care of woodlands, Mr. Damon said:

> I'm satisfied that the growth of my woods has greatly improved by thinning and that it has paid me to do it.

CHANGES CUTTING TACTICS—FINDS WOODS FARMING PAYS

J. D. Upton, a farmer of Warren County, Pa., has found a solution for profitable winter employment right on his farm. He is farming his woods.

Mr. Upton has made a total of $2.500 in the last five years from woods which cost him $300 twenty-five years ago. At the time he bought it, the lumbermen had just got through cutting everything of value from it, and considered themselves lucky to get rid of it at any price. For the last five winters Mr. Upton has made a habit of taking his " daily dozen " out in the timber with a saw and ax in his hands.

He has taken about $500 each year, besides pay for his labor, from an area that would have been called brush a few years ago.

Mr. Upton is not stripping his woods in order to get this return. He is putting it in shape for future production of income. Instead of taking the tall, straight, thrifty trees of small diameters, he is saving them for future use when they will be larger and of greater commercial value. The crooked, weak, and poorly formed trees get the ax, in order that the better ones may have the proper space for growing. Several of the poorer trees are shown in Figure 5. From this inferior part of the woods he is salvaging the wood suitable for market demands.

There are 225 acres in this farm, 50 in cleared and cultivated ground and 175 acres in woods. His woodland comprises an area well above the average for the State of Pennsylvania, but it is growing on land too steep and poor to have a potential value for agricultural crops. He is making more on his 50 acres of bottom land, by farming it intensively, than he would on the entire 225, were it cleared. Instead of extending his cleared area he is tending toward the contraction of it, by planting the marginal agricultural land to forest trees. Said Mr. Upton:

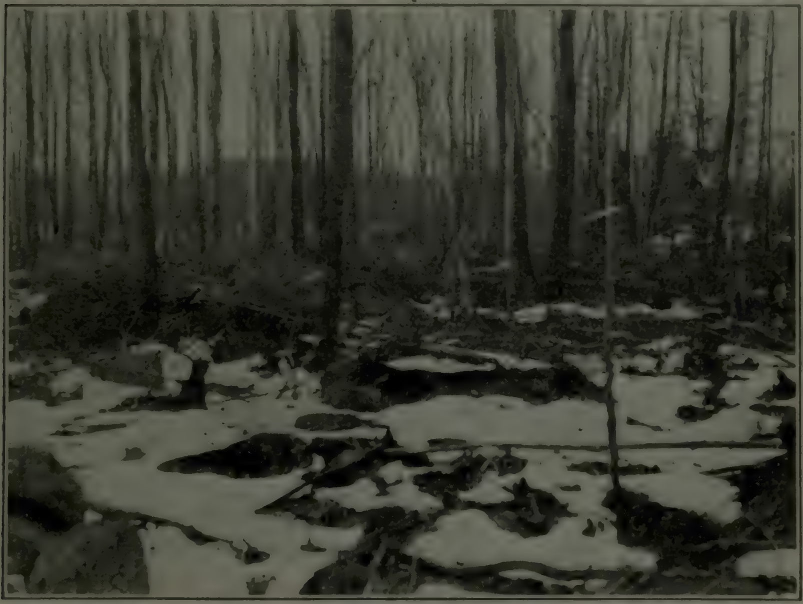


FIGURE 4.—Thinning greatly improved Mr. Damon's woods and yielded a profit

> I couldn't stand the pressure of the high timber prices following the war, so I began cutting in my own woods. For awhile the old habit of cutting held me, and I took the best and straightest trees and passed up the poorer ones. Sitting on a stump one day, I began counting rings of growth. I knew a tree left its mark each year by a ring on the stump. I found out that I was cutting just those trees that were producing the greatest layer of wood. I had been felling white ash, basswood, black cherry, hard maple, red oak, and hemlock, and passing up the beech, yellow birch, and other trees which grew much slower. Right then and there I changed my tactics, for I wanted to keep my woods in good shape for future returns. I am now cutting beech and birch and the crooked, forked, and defective trees of other species.

Mr. Upton does not claim all the credit for his present way of cutting. Having procured several bulletins on forestry, he dug out a working knowledge of timber management. He also got in touch with all the educational agencies in forestry that he could and got one or two men to give him pointers, on the ground. "Most all the $2,500 worth of timber that I have cut so far came from the weed trees of my woods," Mr. Upton says. He has still about 50 acres to go over. His plans are to remove the timber, not all in one year, but in the form of yearly cuts. For one winter's job he planned to cut 25,000 board feet, plus the cordwood which will result from the tops. After he has improved the remainder of his woods, he will go back and cut the trees of all species as they become ripe. He will have to increase his yearly cut to at least 50,000 board feet, in order to keep up with the added growth which will result from his present system of cutting.

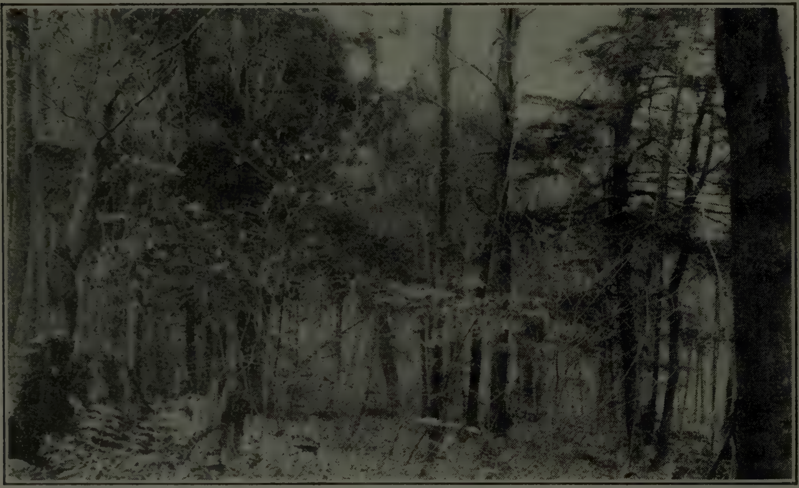


FIGURE 5.—The natural condition of the Upton timberland before any improvement cutting was done

Two years ago Mr. Upton bought a sawmill so that he could better manufacture the timber he was cutting and also custom-saw timber for his neighbors. His time is now almost all taken up between the close of crop season in October and the beginning of field work in spring. He keeps his hired man and teams busy all year round. The mill eventually will have to run yearlong in order to work up the growth of timber from his own and his neighbor's woodlands.

"In the summer I am busy raising wheat, hay, potatoes, and bees; in winter I am busy raising wood," he says. "Work in the woods in cold weather is not only profitable to me, but it is the most enjoyable work of the year."

He sells his wood in the form of lumber, railroad ties, mine props, grape stakes, and chemical and fuel wood. There is very little waste material left in the woods. In fact, if you walked through his woods after he had made an improvement cutting, you would have to look close for even stumps—he cuts them so low. (Fig. 6)

Mr. Upton concludes from his experience that it is not a difficult matter for a farmer to make his woods "loosen up" and take a place in the yearly farm income. He says:

> Farm your woods as you do a crop of corn. Take out the weed trees and the unhealthy and crippled ones, sell them to the wood market, and give the best trees a chance to develop and ripen. Cut the good trees only when they are ripe.

He strongly recommends to his neighbors the practice of "woods farming."

FARMER DEVELOPS PAYING TIMBER PLAN

W. H. Thomas, a farmer living near Rock, Mass., has always lived in the fields and forests and, according to his own statement, has worked in timber ever since he was able to walk. Early in life Mr. Thomas took counsel with three men who had prospered in handling farms and timber, and from these men he got his first suggestions about the value of timber. This counsel gripped his thinking and later stirred him into action. After several years of observation and experience he worked out some ideas of his own regarding management of pine timberlands for producing a cash income at frequent intervals. (Fig. 7.) He has been cutting and growing pine timber on his 200 acres of woodland for a number of years.

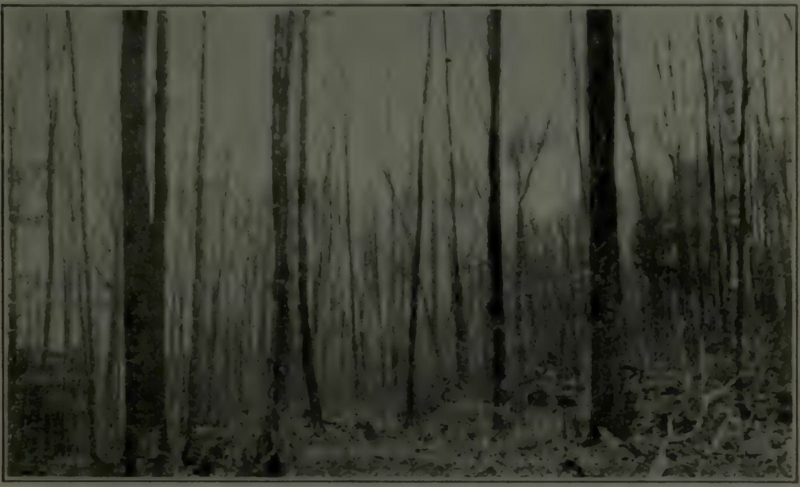


FIGURE 6.—All the crooked, diseased, and poor timber trees have been taken out. A fine group of trees is left for the next harvest

In one year recently, Mr. Thomas cut more than 100 cords of logs and marketed them at a near-by box factory, where he received $12.50 per cord. Mr. Thomas, who is now 75 years old, was unable to do any of the actual work himself but had his cutters take him to the woods, where he directed their operations. He has kept an account of all his expenditures and receipts and says that it cost him $5 a cord for cutting and delivering, which left him a return of $7.50

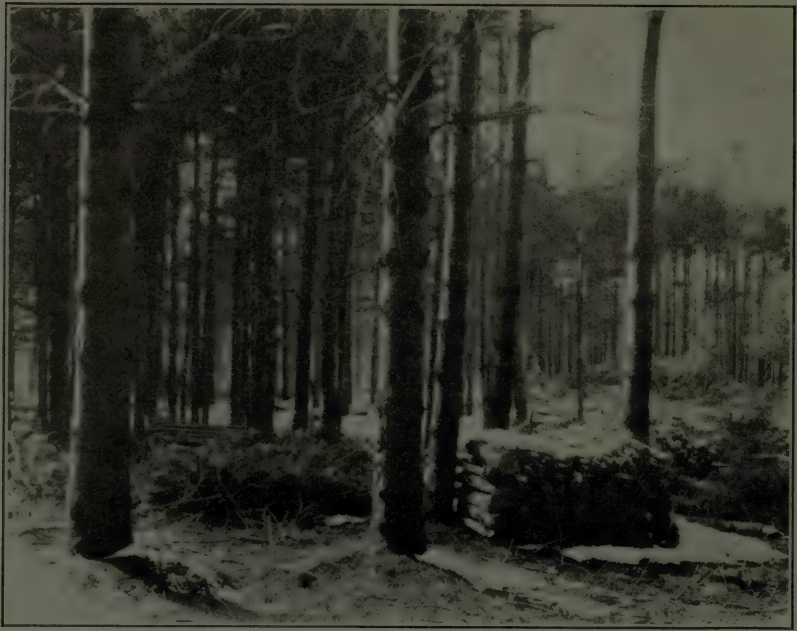


FIGURE 7.—Timber on the Thomas farm being worked according to a definite plan of taking out groups of ripe trees. The trees left will reseed the openings

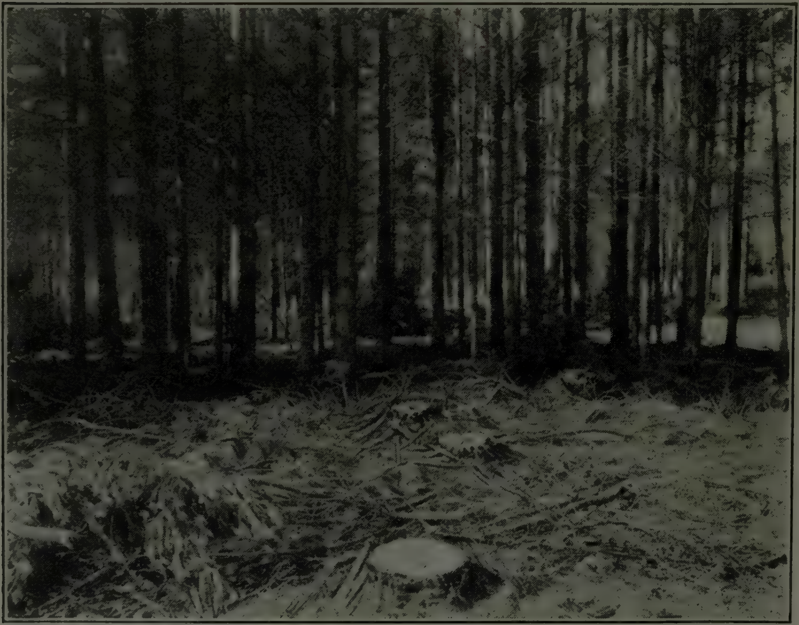


FIGURE 8.—New cutting in the Thomas woods. Most of the trees in the background will be left to grow. Note the low stumps in the foreground

per cord. He believes that a large area of farm woodland provides a splendid opportunity for a farmer to increase his yearly income. He said:

> If a farmer has 100 acres of woods, he can make it pay by cutting a strip of it every year. (Fig. 8.) Every man that has a farm should have at least a 10-acre woodland in order to supply himself with winter wood. A farmer can not hoe and dig potatoes when the snow is on, but he must keep warm, and with a 10-acre woods, if he does some cutting every year, he can have a perpetual supply of fuel.

THE FARM WOODS PROVIDE TIMBER FOR A BARN

Late in the fall of 1916 the barn on the farm of J. C. Brubaker, in Lancaster County, Pa., caught fire. The fire caused a heavy loss to the farmer and his family, so heavy that they took considerable time to decide what to do.

While still undecided, Mr. Brubaker was visited by a local sawmill man who asked him for a contract for sawing the timber for a new barn. Mr. Brubaker was not aware that he had any suitable timber until the millman pointed out the tract which was in sight from the house.

It seemed too good to be true that the material for a barn had been growing right before his eyes and almost within arm's reach. A trip through the woods with the millman convinced Brubaker that the millman was right, as he pointed out the trees which would make the long heavy girders needed, the shorter ones to make the uprights, and still others which would furnish the rafters and other small-dimension pieces.

An agreement was drawn up by which the sawmill man was to set up his sawmill, saw out the needed bill of material, and haul it all to a point where the new barn was to be built. Everything which went into the barn except the siding and the roof covering was on the bill. Later all the timbers and the 2-inch stock necessary for a large tobacco shed, and the rafters needed for still another shed, were cut. Even many of the cross sticks essential in hanging tobacco to dry were made.

The woodland was just an average one. It had been cut over—not too closely—in 1896–97, 20 years before. From time to time during the 20 years some chestnut trees had been cut for fence posts and rails, but the amount taken out at any one time had been small. The trees, in the Brubaker woods were typical of those found throughout the southeastern part of Pennsylvania—tulip poplar, oaks, chestnut, hickories, soft maple, and scattered trees of other species. Even with some cutting the woods had been accumulating timber slowly year by year.

When the sawmill man was through cutting out the bill of material, he found he had cut 60,000 board feet of lumber. There are 8 acres of land in the tract, so that it furnished an average of over 7,000 board feet of lumber per acre. As there had been some cutting done earlier, the 60,000 board feet did not represent all which the land brought forth in the 20-year period. And there were a lot of tops and some crooked trees, which were good only for fuel wood.

Many persons have asked Mr. Brubaker how much money he saved by cutting his own timber. He said he had never attempted to figure it very closely, but he paid $15 per thousand board feet to have the material put down at the barn site ready for use, and it is a little doubtful whether he could have bought what was needed at an average of less than $45 per thousand, on board the car at the near-by freight station. In addition he would have had to haul it to the farm. He feels safe, anyway, in calculating a saving of $2,000 on all the buildings put up. This means then that Mr. Brubaker would have had to lay out just so much more money if he had not owned the timber. Stated another way, he has "sold" the timber in his woodland to himself for the sum of $2,000. In addition, the value of the wood used on the farm, or sold in the eight winters since the cutting was done, has amounted to approximately $800.

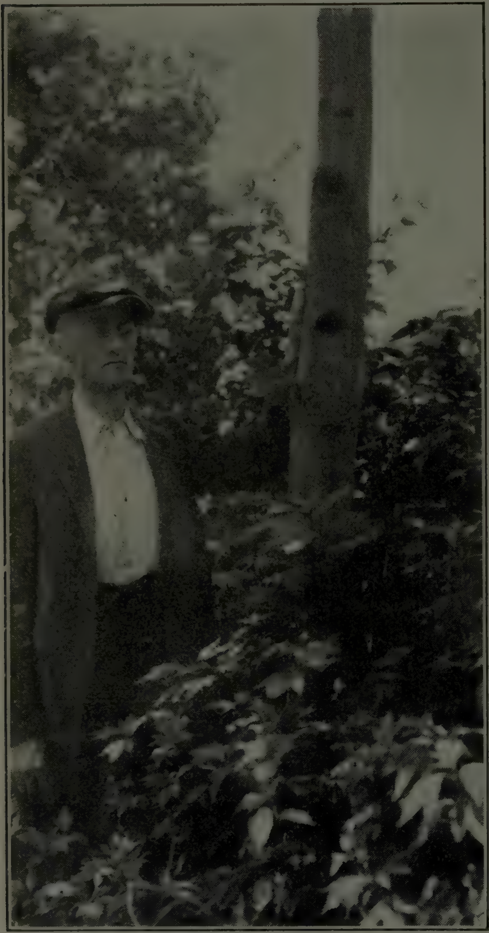


FIGURE 9.—Mr. Brubaker and one of his tulip poplar trees. This tree grew very rapidly after being freed by the cutting of older trees around it

When Mr. Brubaker was asked what he intended to do with the woodland now that its old timber had been cut off, he replied:

> There's one thing sure, I won't clear it for farming. We've lots of good land on the rest of the farm. Some land is good for farm crops; some is good for timber. That piece of land grew a good crop while we weren't watching it. The ground is well covered now with young trees which have started to grow themselves. I'm going to let them stand and watch them grow. (Fig. 9.)

There were a few spots where young trees of good species failed to get started naturally. Some of these have been planted with young white pines and larch. There were other spots where the sawmill man left trees which could not be used in any way for the barn. These have already been cut for wood. Mr. Brubaker will do more than watch his young trees grow. Properly managed, this small woodland will produce enough timber in the next 50 years to build two big barns like the one already built.

FARM WOODS YIELD THIRD CROP OF CONSTRUCTION TIMBER

For the third time a good lot of construction lumber has been sawed from the native timber growing on the White farm near Belle Plaine in Tama County, Iowa. The farm is now being run by G. A. White, who states that the sawing out of this native material "sure keeps the cost down."

The last sawing yielded some 14,000 feet of construction lumber besides the cordwood cut from the tops. The sawing was done at a charge of $10 per thousand board feet for the sawing itself. Getting out the logs for the saw, according to Mr. White, cost about $6 per thousand. The slabs and edgings from the saw were used for fuel to run the engine. The sawyer furnished the crew necessary to run the saw, and the owner took care of getting the logs out of the woods. The logs were cut and hauled out at odd times during the winter and altogether took about a month's time for two or three men.

FARMER TELLS STORY OF HIS WOODS

Fifteen years ago Alexander Bruce, of Berlin, Conn., purchased a farm of 100 acres, about 25 acres of which was in woodland containing a heavy stand of mixed hardwoods. The woodland had trees of all sizes, all shapes, dead and alive; some trees were down and others broken and leaning. There was an undergrowth of saplings, and over the entire tract a scattering of heavy oak and chestnut up to 3 feet in diameter. This large timber should have been cut, but it was impossible to do so without destroying much young growth in felling such large trees. The large timber consequently was left standing, and the crooked, deformed, and dead trees were cut out.

All the fuel wood necessary to heat Mr. Bruce's large house was supplied by the dead wood and small stunted trees during the first four years. Then 11 years ago 115 of the large red oaks were sold for piles, and the chestnut was sold for telephone poles. This timber was sold on the stump with restrictions as to felling the trees. Some young growth was destroyed but not a large quantity.

After the large timber was taken out, it took two years to clean up the waste wood. Some of this was used in the home heaters, and the remainder was made into stove, furnace, and fireplace wood and delivered to the city 6 miles away.

During the last six years, Mr. Bruce has sold two hundred 30-foot piles, cutting them where the stand was thickest. All fence posts, repair lumber, and wood for other farm needs have been taken from his woods during the last 15 years. Mr. Bruce said:

> It may seem a long job, but it pays. This woodland has helped to keep me on the old farm. The material sold from my woods and the money saved in coal bills has amounted to a gross sum of $7,000, not charging for labor by team or man. I can simply say that the time we spent on this woodland would have been time lost without it, as winter time is chore time. True, it is hard work, and if wages were charged for boss men and teams, the margin would be small. But I have another satisfaction in that I still have the woods covered with a stand of timber. Remember, I had the growth of the entire 25 acres chasing me for 15 years, and saplings 15 years ago, not larger than an ax handle, are quite promising trees now.

There are only three things required by any man to preserve his wood and timber for his own use and for the next generation and they are simply common sense, a sharp ax, and a thought for the future.

FARMING THE WOOD

John Fensel, an Indianan whose grandfather was a European forester, says that as a matter of ordinary horse sense he has treated his woodland as a productive part of his farm, and protected it from grazing and browsing animals.

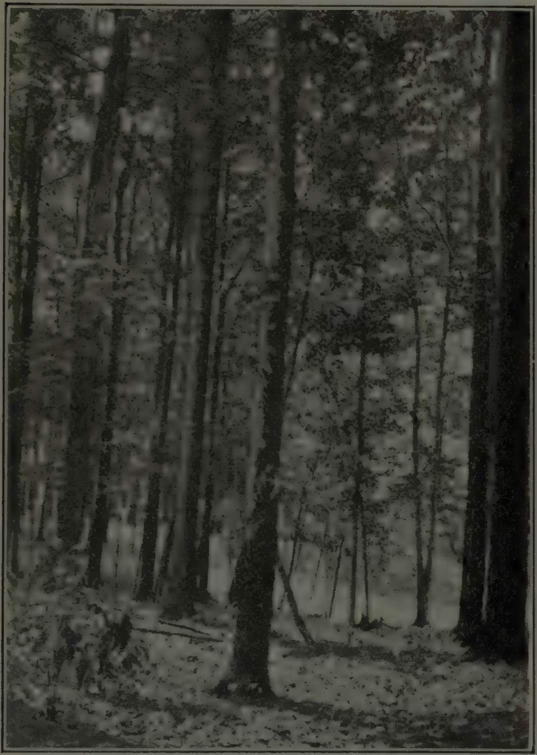


FIGURE 10.—Mr. Ingram's farm woods. A simple cutting plan has been followed which has made the woods profitable over a long period of years

He started with 40 acres, mainly brush and willows, in 1881. There was 1 acre of this land in trees of good quality. He saved the acre stand, and bought, nine years later, 23 acres of cut-over land, in which some seed trees remained.

Since then he has "farmed the woods by common-sense methods." From his own timber he has built two barns, a corncrib, a cow stable, a woodhouse, a chicken house, a garage, and a summer kitchen. He sells 40 cords of stovewood each year for $120. He cuts $40 worth of fence posts each year. In 1914 he sold 10,000 feet of elm for $300. In 1918 he sold 15 cords of ash for $400. He sold $150 worth of timber last year, and was offered $3,000 for the standing timber on the 23 acres for which he paid $650, in 1900, when it was considered waste land. Mr. Fensel has said:

> Farming a bit of woods is profitable. Using it for pasture is waste of land. There is little pasture in the woods, and soon there will be little woods in the pasture, for young trees of almost every kind are eaten by cattle.

TIMBER PAYS FARMER OVER LONG PERIOD

Glenn Ingram, a farmer living near Hastings, Mich., reports very satisfactory returns from 10 acres of woodland. During a period of 18 years, from 1910 to 1928, Mr. Ingram cut 53,000 feet of timber, part of which was sold and part used on the farm for building purposes. The complete record of returns, uses made of timber, and years of cutting is as follows:

1910—cut 14,000 feet; built a farm home.
1913—cut 13,000 feet; sold, and cash put into improvements.
1918—cut 7,000 feet; used for shed, henhouse, and flooring.
1927—cut 17,000 feet; built a barn.
1928—cut 2,000 feet; used for repairs.

In addition to these returns, the woods have produced an average of 100 gallons of maple sirup a year, besides furnishing fence posts, whippletrees, and other products as needed on the farm.

Mr. Ingram has followed a simple cutting plan, taking out the larger ripe trees and leaving the younger ones to grow another crop of timber. (Fig. 10.) Special care was taken in cutting operations to protect all young promising poles and sapling trees. This system kept the woods in good timber-producing condition. The woods were pastured at first, but after studying the problem, the owner decided that his stock damaged the timber, so he has fenced it off.

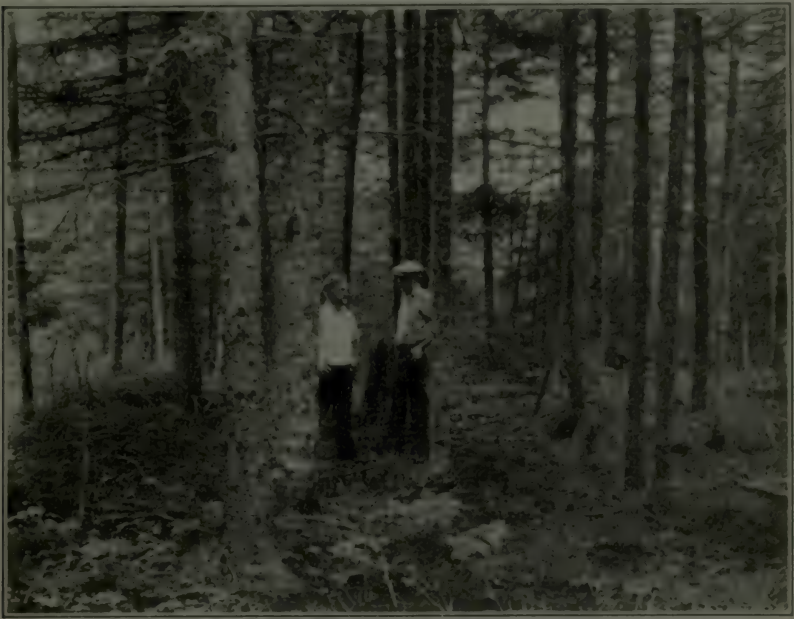


FIGURE 11.—This New Hampshire farm woodland, thinned 20 years ago, shows a good growth

"This 10-acre woodland is just as valuable as any other field on the farm," Mr. Ingram says. A recent offer of $2,500 for the 10 acres was no inducement to Mr. Ingram to sell. He has decided that his woodland holds a very necessary place in his farm-management program.

FARMER HANDLES TIMBER AS A CROP

W. D. Pinkham, a dairy farmer of Coos County, N. H., handles his growing timber as a crop. In 1901 he bought a 30-acre tract of woods for $50. Since that time he has been cutting spruce, balsam fir, hemlock, and birch from it almost yearly. (Fig. 11.) In the winter of 1929, 2,668 board feet of spruce, fir, and hemlock, and 300 cedar posts were cut from the tract. The logs were sawed into boards at the local mill at a cost of $6 per thousand feet. One thousand three hundred board feet were sold, and the remaining boards were to be used in the repair of buildings. Mr. Pinkham paid $49 to get the logs cut and sawed at the mill and the posts made. He received $42 for the lumber sold to neighboring farmers. The posts were sold for about $60, and the lumber for his own use was worth $45. The gross income from the woodland for that winter was $147, and the total expenditures on the woods work was $79. This left a net income of $68. The woodland earned the farmer for the winter of 1929 a little over $2 per acre.

In addition to lumber and posts, Mr. Pinkham gets out other products such as fuel wood, shingles, and timber for use on the farm. He said he had saved considerable money in lumber for farm building.

MORE DOLLARS THAN EXPECTED

L. J. Baxter, of Ida County, Iowa, stated:

> We thinned the woods in accordance with the suggestions made during a woodland-management demonstration. The trees marked for taking out during the demonstration were cut by a neighbor who did the work on a share basis, getting half the firewood. We got the other half of the firewood, the posts, and what saw logs there were. When we sawed we furnished the saw outfit and one extra man, and the neighbor furnished four men.
>
> Our share from the thinning was about 75 loads of wood (wagon boxes 10 by 3 by 3), five hundred and fifty 7-inch posts, one hundred 8-inch posts, and about 500 feet of fine lumber, mostly ash. The sawing of the lumber cost about $10 and was done by a man who was operating a portable sawmill near our place.
>
> Now I am figuring on treating the posts. I looked over the treating proposition while at Ames for the short course and concluded that it was not half as hard a job as it sounded to hear tell about it. The way it looks now I have bought my last post. I have a good supply of posts on hand from the thinning and more good ones coming on in the woodland.
>
> With the saw outfit that I have rigged up for ripping lumber and posts, the material I will get out of the woods is going to mean more dollars than I had ever expected.

CASH INCOME OF $5.83 AN ACRE YEARLY

Few owners of farm woods have any idea how much return they may reasonably expect from woodlands protected from grazing livestock and from which only the " ripe " trees are harvested at regular intervals. Charles Follin, a farmer and woodland owner of Bellville, Ohio, knows what woods will pay, as he has protected his and kept a record of the income. Mr. Follin's woodland tract of 25 acres in Richland County has paid him, during the last 24 years, a yearly cash income of $5.83 per acre. From this must be deducted interest and taxes.

In 1903, the bulk of the large timber on the tract was sold from the land for $3,000. (Fig. 12.) But there was left a large quantity of thrifty-growing tulip poplar, white ash, white and red oak, sugar maple, basswood, and chestnut. Since 1903 four crops of logs have been sold. Once in about every six years the owner has gone through the woods, selecting a ripe tree here and there for cutting.

He has received in the 24 years $3,500 for the timber sold. Mr. Follin believes firmly that every farm woodland that is now grazed can be converted into a paying wood lot if fenced off and given protection from livestock and cut wisely.

HOME-GROWN LUMBER AND FUEL PAY INTEREST ON INVESTMENT

It is a comfortable feeling when the fall plowing is done to know you can go out in the farm woods and get 15 to 20 cords of fuel, year after year, without having to pay out any cash for it. Then there is the harvest of bigger stuff for lumber. That is like a tidy sum in the savings bank; it helps over the hard times.

This is what R. Lee Edmonds believes. His Clover Hill fruit farm lies above Seneca Lake in the Finger Lakes region of central New York. Only 16 of the 108 acres of the farm are in woods. Even this might have been cleared, but a small stream traversing the area made it unfit for tillage. The trees growing in the tract are those common to that section of the State—basswood, sugar maple, elm, beech, white oak, and yellow poplar. Mr. Edmonds's records cover the period from 1893 to 1926.

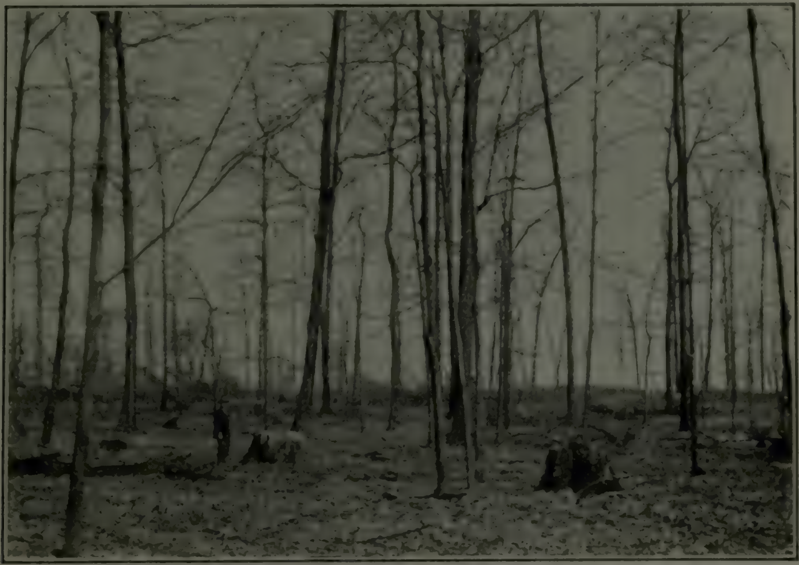


FIGURE 12.—The owner has taken out the ripe trees and left the young thrifty trees for another crop. These woods have been fenced off and given protection from livestock

In 1893, when the first real timber cut was made, the stand was estimated to contain approximately 15,000 board feet to the acre. Mr. Edmonds went over the area carefully and marked the trees he believed should come out. A local lumberman did the cutting, paying him $700 for 70,000 feet of basswood and elm.

The next cut was 4,000 feet of miscellaneous material, in 1900, at $13 per thousand board feet. In 1910, 3,000 feet of poplar brought $18 a thousand; and in 1913, just 20 years after the first cut, 36,000 feet of maple and beech (fig. 13) brought $720 at $20 per thousand. Because of the rising stumpage prices, he received just as much for one-half the amount of material he had sold 20 years earlier.

In addition to these returns Mr. Edmonds has supplied fuel wood for two families all these years, and has sold 70 cords at an average stumpage price of $2 per cord.

Other woodlands may have shown equal yields in the past, but the significant thing about this woodland is the fact that there are still to-day enough veteran trees left to make the stand average close to 10,000 board feet to the acre; and, better still, there is a sturdy race of youngsters, some of them now 6 to 8 inches through, coming on to fill up the gaps.

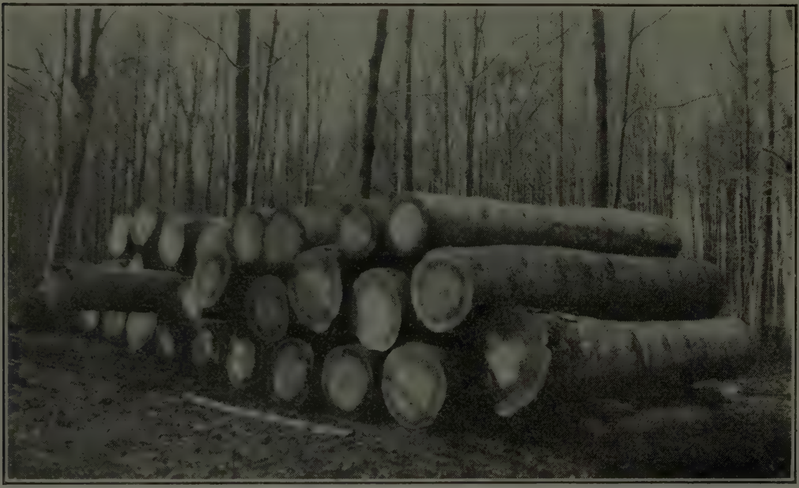


FIGURE 13.—High-grade beech logs ready for the basket factory; cut from the R. Lee Edmonds woodlands

If Mr. Edmonds had permitted stock to run at large through the woodland, as is too commonly the practice in this section he would have nothing left but the old veterans, struggling along under abnormal growing conditions and endangered by the trampling of stock. And with their early decay, his son, in taking over the farm, would have had to look elsewhere for wood and lumber.

Summarizing the figures from the above account, we have:

113,000 feet lumber	$1,526
70 standard cords of fuel wood sold	140
Fuel wood for 2 families for 33 years at $20 per year (a very conservative figure)	660
Total	2,326

For 33 years the average annual gross return from the woodland has been $70.50. The return on a per acre basis has been $4.40 per year. The only annual cash charge to set against this return is taxes, which amount to 57 cents per acre, leaving a clear average annual profit to Mr. Edmonds of $3.83 per acre.

The wood lot of this farm is assessed at $25 per acre. It is held by the owner at approximately double that value. Therefore the annual return of $3.83 per acre represents 7.6 per cent interest on the assumed value.

FINDS TIMBERLAND PROFITABLE—BUYS MORE

Twelve years ago H. H. Butterbaugh, of Carroll County, Ill., purchased 30 acres of virgin timber that had never been pastured or burned. According to his records, he has cut an average of 8,000 board feet of saw timber, 400 split posts, and 15 cords of wood each year since purchasing the 30 acres. The timber was sawed into rough lumber, framing material, and stock for wagon tongues, reaches, and other special uses. Some of the lumber has been used for the frames of new buildings and general construction purposes on the farm. A large part of the clear, straight-grained white oak, used for wagon tongues, reaches, and drag bars, was sold locally at $125 a thousand board feet.

The average value of all the timber was $50 per thousand board feet. The posts have been used on the farm or sold for 30 cents each; and the cordwood, valued at $5 per cord, has been used for fuel. The tract has yielded him $400 for lumber, $120 for posts, and $75 for cordwood, or a total of $595 per year, a gross annual return of a little less than $20 per acre with no deductions for labor, for the products sold and used on the farm.

Mr. Butterbaugh's immature timber, which has been liberated by this cutting, has responded remarkably well, and his white and red oaks are increasing an inch in diameter in from three to four years. He was so well pleased with this area that last year he purchased an adjoining 30 acres. His management methods have been sound but not complicated. He never lets cattle or other stock have access to his timber; he watches to see that fire does not get started; and, when cutting, he takes out only mature trees or those that are diseased or injured. His logs are made from the clear straight parts of the trees, his fence posts from shorter knotty or crooked parts, and his cordwood from the tops and inferior trees.

WOOD CROPS FIT IN WITH GOOD FARM MANAGEMENT

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	ARTHUR M. HYDE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel and Business Administration.	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Solicitor	E. L. MARSHALL.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	R. Y. STUART, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Plant Quarantine and Control Administration	LEE A. STRONG, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*

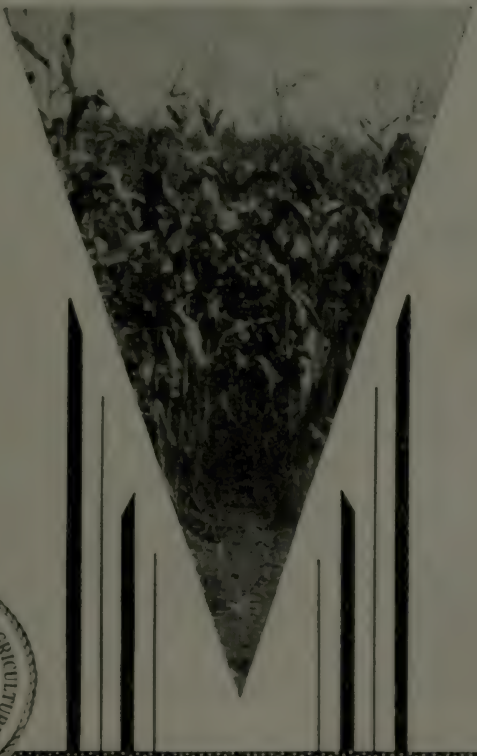
U. S. GOVERNMENT PRINTING OFFICE: 1931

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1681

Adjusting Corn Belt Farming To Meet Corn-Borer Conditions



THE EUROPEAN CORN BORER is recognized as a dangerous enemy of the corn crop. It has already caused serious damage in heavily infested areas in Ontario, Canada. Its eradication is considered economically impossible but it is believed that the injury may be kept at a point so low that little commercial damage will occur during normal seasons. This can be done by using control measures and practices that have proved to be effective.

The natural tendency of producers may be to substitute other crops for corn in an attempt to avoid loss, but the much lower value of other crops that can be grown in the Corn Belt, and the loss of farm feed, will mean that producers eventually will retain corn in the important place it now holds in the organization of farms in the Corn Belt.

A study of the economic situation of cash crops that can be produced in the Corn Belt indicates the impossibility of substituting them for corn to any considerable extent without lowering their farm values and thereby lowering the farm incomes. However, corn-borer control measures can be added to the present farm operations at a cost that is insignificant when compared with the loss that may result if no control is practiced or if corn growing is discontinued.

On some farms some changes in the crops grown and in their sequence will aid materially in controlling the borer and may prove profitable even when borers are not present. The control program for the individual farm should be given consideration at once in order to avoid sudden disturbance of the organization and operation of the farm when control measures do become inevitable. The necessity of concerted effort by all producers in an infested district becomes evident when the life habits of the borer are considered.

Washington, D. C. Issued February, 1932

ADJUSTING CORN BELT FARMING TO MEET CORN-BORER CONDITIONS

By KENNETH H. MYERS, *Associate Agricultural Economist, Division of Farm Management and Costs, Bureau of Agricultural Economics*[1]

CONTENTS

	Page
Introduction	1
Area studied	3
Importance of corn in the organization of Corn Belt farms	4
Acreage, production, and value of crops	4
Acre value of corn	6
Labor used in producing corn and other crops	6
Supply of cash crops grown in the Corn Belt in relation to consumption requirements	7
Wheat	7
Rye	9
Sugar beets	9
Potatoes	10
Supply of cash crops, etc.—Continued.	
Tobacco	10
Fruits and vegetables	11
Soybeans	11
Other crops	12
Possible effect of corn-borer infestation on farm organization	12
Control of the corn borer	13
Adjustments for corn-borer control	16
Suggested adjustments for corn-borer control on a grain farm	17
Suggested adjustments for corn-borer control on a livestock farm	22
Factors affecting cost of control	26

INTRODUCTION

THE EUROPEAN CORN BORER has continued to spread in the United States until it is now known to be at the edge of the important areas of surplus-corn production. (Fig. 1.) Appreciable damage to the corn crop in the Lake region has occurred only in small localities in northwestern Ohio and southeastern Michigan. This can not be taken as an indication that more extensive losses may not occur in the future, however. There are now sufficient numbers of borers in northwestern Ohio and southeastern Michigan to produce a serious infestation in a single season under favorable climatic conditions. Studies of the life history of the borer, and experiments in controlling it, have shown the economic impossibility of eradicating the insect or of confining it to a limited area. But the possibility of reducing the number of borers has been amply demonstrated, and indicates the possibility of continuing to produce corn with only small reduction in farm incomes.

Control measures,[2] consisting of completely utilizing or destroying the entire corn plant by feeding it to livestock, burning it, or plowing it under in the field, are recommended by the Bureau of Entomology, United States Department of Agriculture. This work may be done during the 10 months or more when the borer is in the larval or the pupal state.

---

[1] Recognition should be given V. B. Hart, of Cornell University, who started this study while temporarily employed by the Bureau of Agricultural Economics.

[2] For details concerning the life history of the corn borer and control measures, see Farmers' Bulletin 1548, The European Corn Borer, Its Present Status and Methods of Control.

These facts suggest that the farmer should study further the adjustments which he can make in the organization and operation of his farm to include necessary control measures with the least possible reduction in his income. The advisability of including these control measures under corn-borer conditions must be balanced against the advisability of making more drastic changes in long-established crop and livestock organizations. That the success of such a plan depends upon the concerted action of all producers in the locality is evident, since the borer's natural spread by flight may extend several miles in a season. Little additional labor or expense in actual control work should be incurred until a threatening infestation becomes evident, but plans for a definite control program on each individual farm should be made at once to avoid sudden disturbance of the farm organization when the necessity for changes does arise.

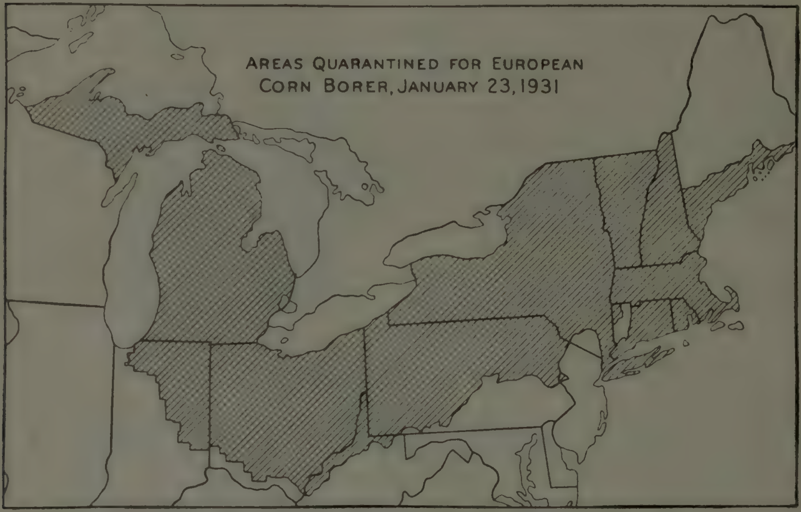


FIGURE 1.—The natural spread of the corn borer is by flight of the adult insect and varies annually with seasonal conditions

The continued spread and the increased severity of the borer infestation may lead many producers to look for some other crop to take the place of all or a part of the corn in their rotations. The possibility of profitable substitution is limited. The purpose of this bulletin is to discuss the extent to which such substitutions are economically feasible and to indicate the possibility and to show the estimated cost of adjusting farm organization and operation to meet corn-borer conditions by adding control measures.

The general types of farming found in a given area are followed because they are believed to be the most profitable under existing conditions as determined by soil, topography, climate, available markets, transportation facilities, and other factors. These conditions are constantly changing and adjustments to meet these changes should be made. On the other hand, drastic changes are usually costly and should be made only after a careful study of the physical, biological, and economic factors involved. The acreages of crops grown generally indicate the relative importance of those crops. This bulletin shows the relative importance of corn and other field crops on the basis of market value, feed production, and economic use of available labor and equipment. Production and consumption of the important cash crops will be discussed to show the economic situation of these crops. The possible methods of adjusting farm operations to include necessary control measures, and the economic feasibility of those methods under varying conditions, will be shown by discussing farm organizations typical of the district studied. Obviously, definite recommendations for specific adjustments to meet corn-borer conditions can be made only after a detailed study of limited districts, and the final details must conform to conditions on the individual farm.

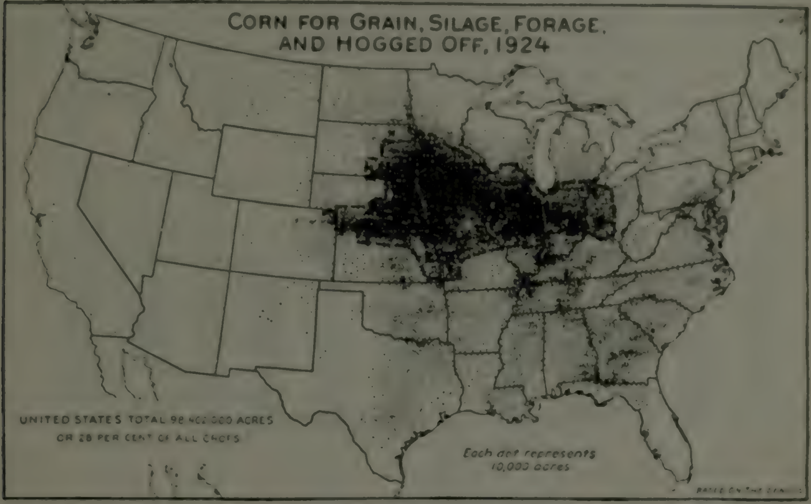

CORN FOR GRAIN, SILAGE, FORAGE, AND HOGGED OFF, 1924
UNITED STATES TOTAL 98,402,000 ACRES OR 28 PER CENT OF ALL CROPS
Each dot represents 10,000 acres

FIGURE 2.—The inclosed area produced 47.8 per cent of the total corn acreage of the United States in 1924. Nearly 44 per cent of the crop land in this area was planted to corn.

AREA STUDIED

This bulletin applies in general to the area commonly known as the Corn Belt, an area covering all or parts of 11 North Central States.[3] Differences in the life history of the borer, in the plants affected, and in the type of farming in the New England and Middle Atlantic States make the control problem in those States, different from that in the Corn Belt. Figure 2 shows the heavy concentration of corn in the Corn Belt. In this bulletin particular attention is paid to the area outlined on this map. Only those crops that are or may be grown in that area will be discussed as possible substitutes for corn. Farmers outside this important corn-growing area will face the control problem, but their relatively small acreage of corn per farm should present no serious clean-up problem.

---

[3] The 11 North Central States included are Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, South Dakota, Nebraska, and Kansas.

IMPORTANCE OF CORN IN THE ORGANIZATION OF CORN BELT FARMS

A study of the distribution, acreage, production, and value of corn in the United States shows the important place that this crop fills in the agriculture of the entire country and indicates that careful thought should be given to any plan for discontinuing corn growing or reducing the normal corn acreage. Corn is grown in every State and is especially important in the entire eastern half of the country; but it reaches its greatest prominence in the 11 North Central States. These 11 States included 62 per cent of the acreage and produced 71 per cent of the volume of all corn in the country during the five years 1924–1928. The relative importance of corn varies within these States. Soil, topography, and climatic conditions are most favorable in the area commonly known as the Corn Belt. (Fig. 2.) There corn is grown on as much of the crop land as available labor and equipment, soil fertility, and the need for small-grain and hay crops will permit.

ACREAGE, PRODUCTION, AND VALUE OF CROPS

The acreage, production, and value of the principal crops grown in the 11 North Central States during the five years 1924–1928 is shown in Table 1. The average of 62,189,000 acres in corn grown annually was equal to 36.3 per cent of the estimated acreage of all crops. Hay was grown on 21.7 per cent of the harvested crop land, oats on 18.4 per cent, wheat on 14.9 per cent, and barley and rye on 3.8 per cent. The importance of corn in the Corn Belt proper is shown by the 1925 Census of Agriculture, in which 43.6 per cent of its crop land was reported as having been harvested for corn in 1924. Single counties in this area showed 65 to 74 per cent of their crop land in corn. Although on many farms the acreage of corn may be greater than it should be from the standpoint of permanent soil fertility, the increasing use of legume crops, especially sweetclover, is making it possible to grow more corn in the rotation with increasing yields per acre.

TABLE 1.—*Acreage, production, and value of crops produced in the Corn Belt States; average, 1924–1928* [1]

Crop	Acreage harvested	Average yield per acre	Total production	Average value per unit	Total farm value
	1,000 acres	*Bushels*	*1,000 bushels*	*Dollars*	*1,000 dollars*
Corn	62, 189	30. 9	1, 918, 896	0. 78	1, 494, 659
Wheat	25, 628	15. 0	385, 112	1. 23	472, 666
Oats	31, 474	33. 2	1, 045, 671	. 41	427, 579
Barley	4, 800	27. 7	133, 179	. 61	81, 802
Rye	1, 674	14. 7	24, 547	. 87	21, 410
		Tons	*1,000 tons*		
Hay	37, 150	1. 4	51, 881	11. 05	573, 197
Total	162, 915				3, 071, 313
Estimated total, all crops	171, 341				3, 736, 000

[1] Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, South Dakota, Nebraska, and Kansas. Estimates of crop reporting board, Bureau of Agricultural Economics.

During the above-mentioned 5-year period the farm value of corn was equal to 40 per cent of the estimated total value of all crops produced in the 11 States, and was nearly equal to the combined value of wheat, oats, barley, rye, and hay. The value of other crops, which include fruit, truck crops, canning crops, etc., was equal to 17.8 per cent of the value of all crops. Figure 3 shows the relative total value of corn and other crops produced in each of the 11 States during the five years 1924–1928. Although corn is the important crop in all of the Corn Belt (fig. 1), the relative importance of the small-grain crops varies with soil and climatic conditions. Winter wheat is important in the cropping system in Ohio and Indiana, and along the southern edge of the Corn Belt in Illinois, Missouri, Nebraska, and Kansas. North of the winter-wheat area oats are the principal small-grain crop, and spring wheat is important in the extreme northern sections.

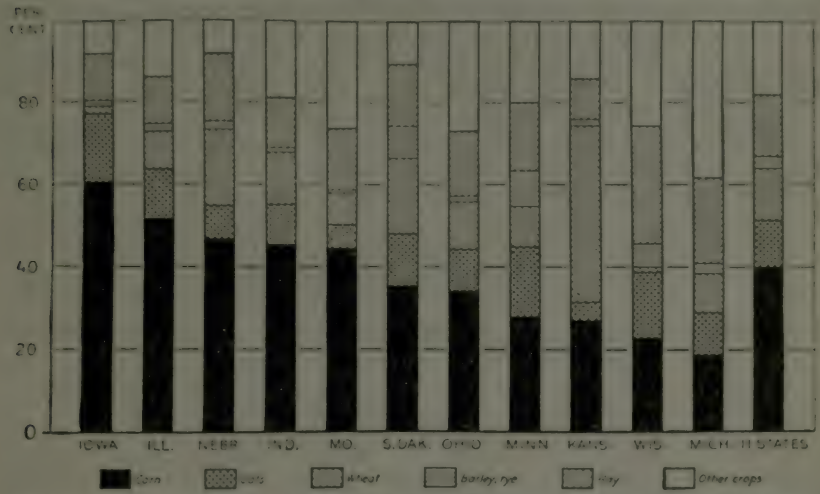


FIGURE 3.—RELATIVE VALUE OF CROPS PRODUCED IN CORN BELT STATES, 1924-1928

Iowa and Illinois are more typical of Corn Belt conditions than those States which lie largely outside the important corn-growing area.

Although corn makes up a large part of the total value of all crops, it is significant that only 7.3 per cent of the cash farm income in the 11 States came from its sale. From 85 to 90 per cent of the corn crop in the United States is fed to livestock and is marketed as meat or other livestock product. Less than 10 per cent is used directly as human food, and less than 1 per cent is exported as grain. The relation of corn production to livestock production is indicated by the fact that on January 1, 1925, 70 per cent of all hogs in the United States, nearly 50 per cent of all steers over 1 year old, 38 per cent of the beef cows, and 23 per cent of the sheep, were in the 11 States which had produced nearly 70 per cent of the United States corn crop in 1924. Corn is a bulky product in relation to its value and is not shipped over long distances. However, much corn is sold for cash and shipped out of one district centering in eastern Illinois and extending eastward into Indiana, and out of another district which includes western Iowa and adjacent portions of South Dakota and Nebraska.

ACRE VALUE OF CORN

Corn holds its important place in the organization of farms in the Corn Belt because of its relatively high value per acre, the large quantity of high-quality feed produced per acre, and the profitable use that can be made of labor and equipment in its production.

The average farm value of corn per acre in the 11 Corn Belt States during the five years 1924–1928 was $24.03, determined by yield per acre and price per bushel. It was the most valuable grain crop in each of the 11 States, except Kansas; there it was outranked by wheat. In Iowa, where 25 per cent of the corn is shipped out of the county where grown, the average yield was 37.6 bushels per acre with a farm value of $28.63. In Ohio, where only 16 per cent is shipped out, the value per acre was $30.82, with a yield of 37.2 bushels.

With average yields, corn produces 43.6 per cent more digestible feed per acre than barley and more than twice as much as oats, the two most important substitute feed crops. This is shown in Table 2.

TABLE 2.—*Production of feed and digestible nutrients per acre of corn, oats, and barley in Corn Belt States*

Feed crop	Average yield per acre, 1924–1928 [1]		Digestible nutrients	
			Per 100 pounds grain [2]	Per acre
	Bushels	*Pounds*	*Pounds*	*Pounds*
Corn	30.9	1,730	81.9	1,417
Barley	27.7	1,330	74.2	987
Oats	33.2	1,062	66.3	704

[1] 11 Corn Belt States. Higher yields are considered normal in the principal corn-growing area.
[2] From analyses of Feeds for Farm Animals, Bureau of Animal Industry, U. S. Department of Agriculture.

LABOR USED IN PRODUCING CORN AND OTHER CROPS

The amount of labor used in producing corn or any other crop varies in different localities and from farm to farm, depending on the kind and number of operations in preparing the seed bed and in harvesting the crop. Although corn production requires more labor than does the production of small grains, that labor is spread over a longer period, and the labor in harvesting comes at a time when little is required on other crops. Table 3 shows the amount of man labor used in growing and harvesting an acre of corn and an acre of the common small-grain crops, as shown by records kept by farmers in cooperation with various State experiment stations.

Under normal conditions and with a given amount of labor available, the acreage of corn which can be planted and given its first cultivation at the proper time, is the acreage which can be produced, for these two operations are the ones which require the most labor, and therefore fix the limits of the acreage. The distribution of the labor and the possibility of, for a few days, delaying some operations on corn in favor of work on more exacting crops, enable the Corn Belt farmer to utilize his available labor more completely in the production of corn than in that of any other crop. The seasonal distribution of labor on corn, oats, wheat, and soybeans in east central Illinois is shown in Figure 4. The large amount of labor required on the small grains during the harvesting season is shown. The table also shows that the principal demand for labor on small grains comes when little labor on corn is necessary. This supplementary relationship between small grains and corn makes possible a more complete and profitable utilization of labor, power, and equipment through combining production of the different crops. (Table 3.)

TABLE 3.—*Man labor used per acre on grain crops in the Corn Belt States during selected years*

State and period	Corn [1]	Oats [2]	Wheat [2]	Barley [2]	Rye [2]
	Hours	*Hours*	*Hours*	*Hours*	*Hours*
Ohio,[3] 1920-1924	18.04	8.33	8.34	(4)	(4)
Illinois,[5] 1920-1926	14.14	6.77	11.16	(4)	(4)
Iowa,[6] 1925-1927	18.70	9.00	11.70	9.00	(4)
South Dakota,[7] 1922-1924	15.40	6.06	6.52	5.70	7.33

[1] Corn husked by hand from standing stalks.
[2] Small grain threshed from shock.
[3] Greene County, Ohio; Ohio Agricultural Experiment Station Bulletin 396.
[4] No data available.
[5] Champaign and Piatt Counties; Illinois Agricultural Experiment Station Bulletin 329.
[6] Iowa County; Iowa Agricultural Experiment Station Bulletin 261.
[7] Kingsbury County; South Dakota Agricultural Experiment Station Bulletin 226.

SUPPLY OF CASH CROPS GROWN IN THE CORN BELT IN RELATION TO CONSUMPTION REQUIREMENTS

Reduction in the acreage or yield per acre of corn in the United States would probably result in higher prices if the demand remained as at present. Such a situation normally results in an increased use of substitute feed grains, principally oats and barley, especially for young stock and dairy cattle. The prices of these grains generally follow the trend of corn prices for this reason. Substitution of oats and barley for a part of the corn acreage, therefore, would not result in much lower prices for these grains. Less meat or livestock products could be produced, however, with the smaller amount of feed, and the farm income probably would be lowered if any large amount of this substitution were made.

The prices of the important cash crops are not determined by their feeding value. Increases in supply of these crops and their products, if there were no change in demand, would seriously disturb present price relationships. The relation of the current production of these crops to the existing requirements for human food and for other known uses, determines the extent to which their substitution for corn on any considerable part of the present corn acreage is economically feasible.

Some figures on the production and consumption of these crops are given below.

WHEAT

The average annual acreage of wheat in the United States during the five years 1924–1928 was 55,663,000 acres and the total annual production was 833,165,000 bushels. Wheat is the only strictly cash crop grown extensively in the Corn Belt. During these five years an average of 25,628,000 acres was grown annually in the 11 Corn Belt States, an acreage equal to only 41.2 per cent of the acreage of corn. A large part of this is grown in the parts of these States outside the Corn Belt proper. Wheat is the principal bread grain of the American people, nearly 5 bushels per capita being consumed annually. From 1924 to 1928, inclusive, the United States exports of wheat and

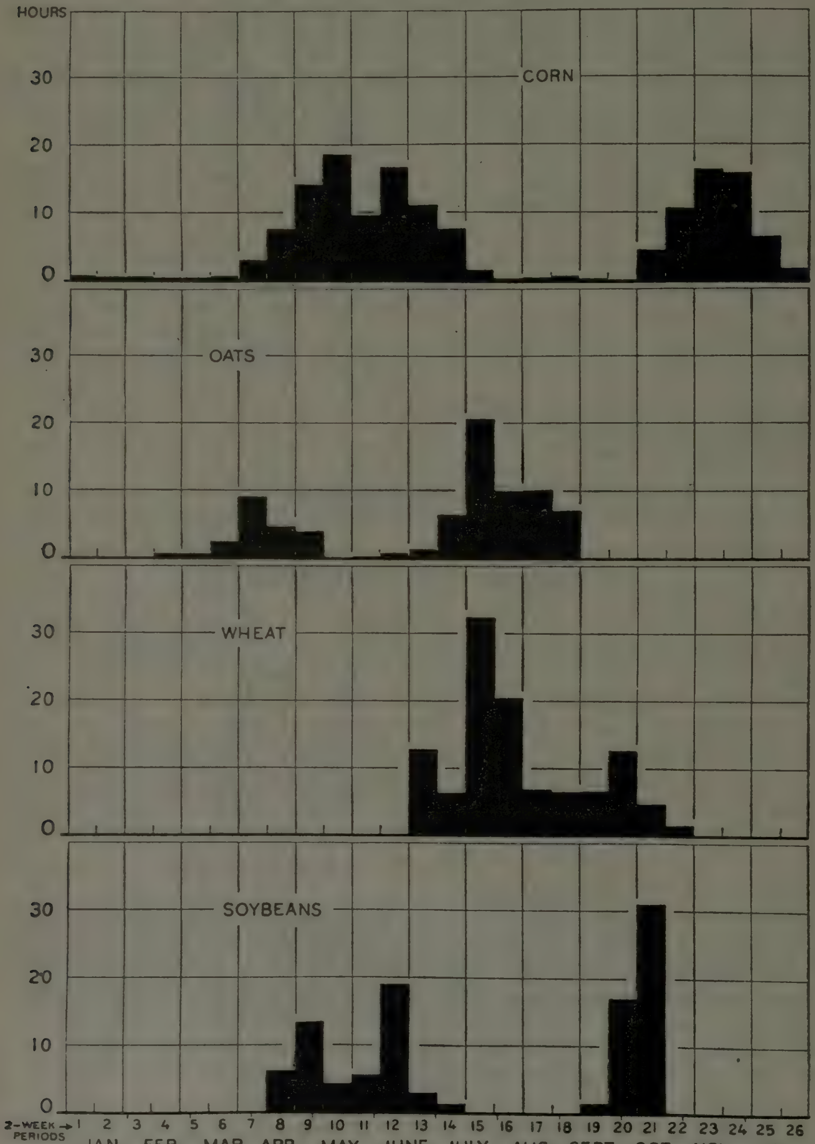


FIGURE 4.—DISTRIBUTION OF MAN LABOR USED IN GROWING AND HARVESTING 10 ACRES OF GRAIN CROPS IN EAST CENTRAL ILLINOIS

The labor on oats and winter wheat comes largely at a time when little is necessary on corn. Data from Illinois Agricultural Experimental Station Bulletin No. 329.

wheat flour amounted to 21.3 per cent of the total production. About 10 per cent of the United States crop is required for seed, less than 5 per cent is used for feed, and the remainder, or from 60 to 70 per cent, is used for human food.

The relation between domestic production and requirements of wheat is clearly shown by the large part of the crop that is exported. Since one-fifth of our crop is sold on the world market the price received by wheat producers in the United States is determined largely by world supply and demand. Under the stimulus of high prices during the World War, the acreage of wheat in the United States was greatly increased by new land being brought into production. A considerable part of this new land is still being used for wheat production. The price of wheat during recent years has not been considered high enough to warrant any increase in acreage except under extremely favorable conditions. It is generally believed that little improvement in the price situation can be expected until the domestic requirements for food, feed, and seed, more nearly equal domestic production. Apparently there is now no real opportunity to substitute wheat for any major portion of the present corn acreage in the Corn Belt.

However, growing more winter wheat in certain districts would aid in controlling the corn borer because of the better distribution of labor. If it becomes necessary to reduce the corn acreage in order to clean up the stalk fields effectively, a fall-sown crop would distribute the labor in such a way as to reduce the amount necessary in the spring.

RYE

The average annual acreage of rye in the United States from 1924 to 1928, inclusive, was 3,766,000 acres. The greater value of other grains for feed and the decided preference of the American consumer for wheat flour have kept the production of rye at a low level. More than 90 per cent of the world rye crop is produced and consumed in Europe. During the war period, with increased foreign demand, the production in the United States increased rapidly but with the return to normal conditions has dropped to a little above the pre-war level. During the five years 1924–1928 the annual production was 50,851,000 bushels, about one-half of which was grown in the 11 North Central States. Nearly 48 per cent of the crop was exported during this period. Although inferior to corn, oats or barley as a feed grain, a part of the rye crop is fed. In 1924, with a short world crop, 76.7 per cent of the United States crop was exported. In 1925, with an estimated world crop 37 per cent larger, the United States exports amounted to only 27.2 per cent of the crop, and a much larger proportion was fed.

Rye is not at present considered a profitable cash crop if other small grains can be grown, and since foreign agriculture has recovered somewhat from war conditions there is little opportunity for substituting rye on any of the present corn acreage in the Corn Belt without decreasing the farm income.

SUGAR BEETS

The production of sugar in the United States was equal to only 17.6 per cent of the total consumption during the five years 1924–

1928. Insular possessions produced 28 per cent, and the remainder came principally from Cuba. Ninety-two per cent of the domestic production was beet sugar. The total acreage used in producing beets, however, was only 705,000 acres, or approximately 1 per cent of the acreage in corn. In the Corn Belt sugar beets are an important crop only in northwestern Ohio and adjoining sections of Indiana and Michigan. Here they are grown under contract with sugar factories, the price being set in advance, with a possible bonus depending on the sugar content and on the price of sugar at harvest time.

The average price received by the producer during the last few years has been from $6 to $7 per ton. At this price beets compare favorably with corn in value per acre after the necessary cash costs for labor, seed, fertilizer, machine hire, etc., are deducted. Other factors, however, make any great amount of substitution impossible. Sugar beets require a large amount of labor in growing and harvesting other than the contract labor used in blocking and thinning. They can be grown profitably only on soils of high natural fertility, and even then a considerable quantity of fertilizer is usually necessary. Climatic conditions also have a distinct effect on the sugar content. In spite of the small amount of sugar produced in the United States when compared with the domestic requirements for sugar, the demand for beets at present is limited, and any considerable increase in acreage would result in lower prices.

POTATOES

The average annual acreage of potatoes during the five years 1924–1928 was 3,363,000 acres, and the average annual production was 392,605,000 bushels. Potatoes are not an important commercial crop in the Corn Belt, the surplus-producing districts lying farther north than the latitude at which corn is at its best. A crop of about 400,000,000 bushels seems to be as large as can be marketed at prices satisfactory to the producers. Potatoes do not enter the export trade to any extent, the surplus above domestic requirements for food and commercial uses being fed to livestock or remaining unharvested. An increase in potato acreage amounting to only 1 per cent of the corn acreage would, with average yields, increase potato production by nearly 30 per cent and would result in ruinously low prices. Therefore, there seems to be no possibility of considering potatoes as a general substitute for corn under corn-borer conditions.

TOBACCO

The economic situation of tobacco is similiar to that of potatoes. The total annual acreage in the United States for the period 1924–1928 was 1,719,700 acres. Tobacco is not grown to any extent in the Corn Belt except in southwestern Ohio and the adjoining section of Indiana and in southern Wisconsin. About one-third of the tobacco crop is now exported, and stocks in the United States were 20 per cent greater on January 1, 1928, than five years earlier. Tobacco requires a great deal of labor and special equipment, and soil and climatic conditions have a distinct effect on the type and quality produced.

FRUITS AND VEGETABLES

Profitable production of fruit and vegetable crops on a commercial scale is dependent upon soil and climatic conditions, a relatively cheap supply of labor, and available markets. During the last 10 years improved refrigeration and transportation facilities have resulted in a great expansion of the small-fruit and vegetable industry in the South and West, where climatic conditions are most favorable.

During the five years 1924–1928 the acreage of 18 important vegetable crops averaged 2,169,932 acres. In the Corn Belt, production for immediate consumption is limited to small localities adjacent to large consuming centers. Vegetables for canning, however, principally sweet corn, tomatoes, cabbage, and green peas, are important crops in many districts. If favorable contracts for handling the canning crop can be secured and if labor is available for the hand work, these crops usually return a fair income. The location and capacity of canning factories determine the area where these crops may be grown profitably and the acreage which can be grown. Sweet corn is more susceptible to corn-borer damage than field corn and is thus eliminated as a possible substitute. The acreage of vegetable crops, both for canning purposes and for immediate consumption, may expand in the future, but only a very minor portion of the present corn acreage can be used for such crops if production is to remain profitable.

The production of tree fruits is an enterprise necessarily extending over a period of several years. The price received by producers of the principal fruits usually varies closely with the annual production. The general outlook is for continued heavy or even increased production of all the important fruits. With the relatively small acreage necessary to produce a crop sufficient to meet consumption requirements, and the trend toward the large specialized fruit farm, it is apparent that no opportunity exists to grow fruits on present cornland.

SOYBEANS

Soybeans have been grown for hay or as an interplanted crop in the Corn Belt for several years. Until recently the production of beans for grain, however, has been limited to those needed for seed, only the beans of poor quality being fed to livestock. Practically no soybean oil was manufactured in the United States until after 1921, when a tariff of 2½ cents per pound was put on imports. In 1922–23 about 1,482,000 pounds of oil was made from soybeans, and in 1928–29 this quantity had increased to 7,285,000 pounds. The increased use of soybeans for the manufacture of oil and for feeding has resulted in a larger acreage of beans being grown. Illinois, Missouri, Indiana, and North Carolina are the leading States in soybean production.

A considerable increase in soybean acreage may be profitably made in districts that are well adapted to the crop. In spite of the increase in oil production a considerable quantity of soybeans, soybean oil, and soybean-oil meal is imported each year. The value of the beans as a source of protein in livestock feeding is becoming more generally recognized. Although limited quantities may be fed to hogs the tendency of the whole grain toward producing soft pork makes the oil-meal cake, a joint product of the oil industry, more desirable.

The distribution and amount of labor required in the production of soybeans for grain is similar to those needed for corn, and no additional equipment is needed on the average farm. The total acreage of soybeans harvested for grain in 1928 was only 656,000 acres; if in the near future it were increased by only a very small part of the present corn acreage in the Corn Belt, the price of soybeans would be decreased.

OTHER CROPS

Flax, buckwheat, peppermint, and grass seeds are other cash crops that are grown in limited districts of the Corn Belt. The small acreage on which they are grown is sufficient to indicate the impracticability of substituting any one for any considerable part of the corn acreage.

Present domestic production of flax is less than one-half domestic requirements. Although a considerable increase in the acreage is ordinarily possible without reducing domestic prices to the world level, any such increases would logically be made in the area north and west of the Corn Belt.

Buckwheat is produced on scattered individual farms in all of the Corn Belt States but is of minor importance in any district.

Peppermint is grown on a commercial scale only on the muck land of southern Michigan and northern Indiana and is not a profitable substitute for corn.

POSSIBLE EFFECT OF CORN-BORER INFESTATION ON FARM ORGANIZATIONS

Unless there is a change in the market value of corn, any additional equipment or hired labor required to control the European corn-borer will result in lower farm incomes. Producers in uninfested areas will have a comparative advantage in corn production over those in infested areas because of the higher operating cost to the latter. The damage to the corn crop will be most severe in the best corn-growing districts where corn is most important in the cropping system. The acreage on the individual farm will be limited to that which can be properly cleaned up to control the borer. Should it become necessary, in order to secure adequate control, to reduce the acreage on the best corn-producing farms, some expansion probably will take place in other areas. A considerable amount of corn is now shipped into the Eastern and Southern States for feeding work stock and dairy animals. Higher corn prices, resulting from lower production in the Corn Belt, would induce producers in these deficit areas to more nearly balance their production and livestock feeding requirements.

The foregoing discussion indicates the probable results if producers follow their natural tendency to reduce the acreage of corn grown and substitute other crops. The results of such drastic changes in cropping systems are demonstrated in the results of a similar attempt by farmers in the southwestern part of Ontario, Canada. This region is similar to the Corn Belt of the United States in crops grown in the rotation. A complete loss of the corn crop occurred in many fields in this region as a result of severe corn-borer infestation during the period 1924 to 1927. The acreage of corn grown in Kent and Essex Counties was reduced from 161,012 acres in 1924 to 47,527 acres in 1927. Investigations by the Agricultural and Experimental Union in 1926 showed that feed grains (oats, barley, and mixed grains) were sown on 46 per cent of the total acreage formerly planted to corn. Cash grain crops replaced corn on 29 per cent of the former acreage, 13 per cent was occupied by crops of high cash value (sugar beets, tobacco, and canning crops), 10 per cent was put into forage crops, and 2 per cent into soybeans, potatoes, and miscellaneous crops. It was estimated by the department of economics of the Ontario Agricultural College that this decrease in corn acreage would result in a decrease in the farm income equal to $5 per acre of cleared land.

A general clean-up program over the entire region was inaugurated in 1927, and, aided by climatic conditions unfavorable to the borer, has resulted in a much less severe infestation. The smaller losses from the borer damage in 1927, and the knowledge that control measures were more practical and economical than was substitution of other crops for corn, resulted in the corn acreage in the two counties being increased to 61,279 acres in 1928 and to 75,706 acres in 1929.

CONTROL OF THE CORN BORER

Practices which involve complete utilization or destruction of the corn plant and which have proved most practical and effective in destroying large numbers of borers are: (1) Feeding the entire corn plant as silage or fodder; (2) completely plowing under all stalks and other débris in the field, and (3) breaking or shaving, raking, and burning the stalks in the field. Control measures are almost equally effective at any time after the corn is harvested and before the adult insects begin to emerge in the spring, normally during the last 10 days in June. The control program, however, should be so planned that this work will be completed by May 1 in order to provide a margin of safety and to avoid conflict with the regular spring work.

The method of control used on the individual farm should be determined largely by the usual methods of harvesting the corn crop and preparing the corn ground for the following crop. Only a small part of the corn crop in the Corn Belt is usually cut for silage or fodder, and on most farms only a small part can be profitably utilized in this form. On land where corn follows corn in the rotation the ground is usually plowed but where the stalk ground is sown to oats it is only disked. In some districts the ground can not be plowed for oats because of soil and climatic conditions. On farms where the entire corn plant can be utilized as fodder[4] or silage, cutting may become more common under corn-borer conditions. (Fig. 5.) Where plowing is the usual method of preparing the ground for the following crop, no additional labor is necessary to control the borer except that needed in doing a better job of covering the stalks. (Fig. 6.) Plowing as now done on many farms will not be effective in controlling the borer. Where the stalks are usually disked for oats, plowing will ordinarily prove the most economical method of control. In those regions where stalk ground

---

[4] The Husker-Shredder on Eastern Corn Belt Farms, Farmers' Bulletin No. 1589.

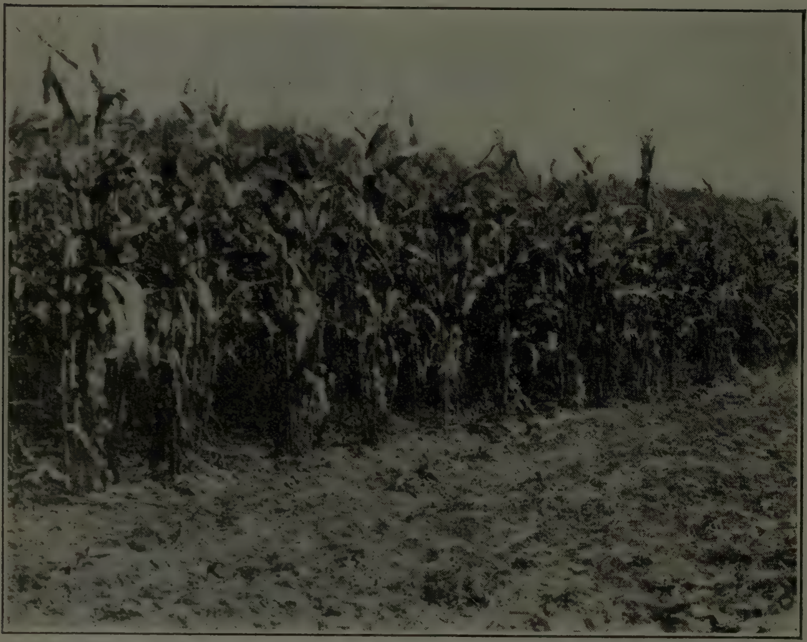


FIGURE 5.—Where the fodder can be utilized in feeding, low cutting may be an economical method of control

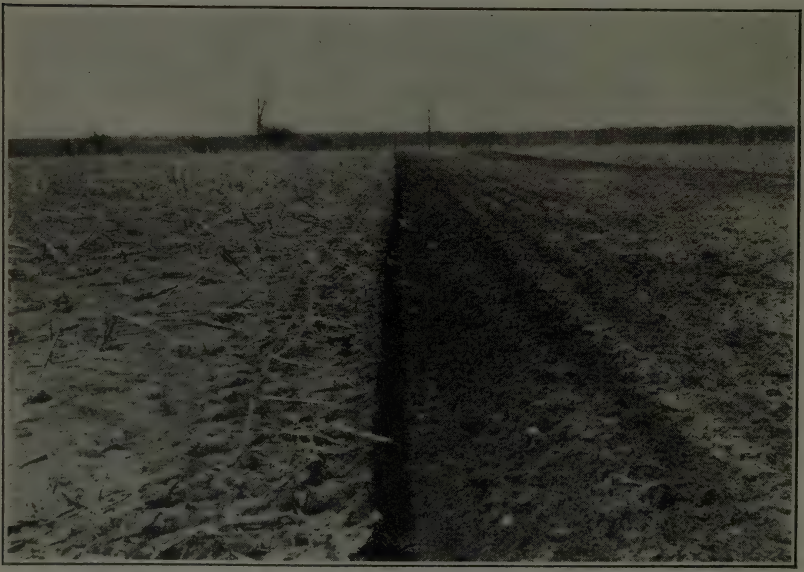


FIGURE 6.—A clean job of plowing is effective in controlling the corn borer and requires little extra labor or costs

can not be plowed for oats, however, the stalks must be broken or shaved cleanly, raked and burned in the field before disking. (Fig. 7.)

The amount of additional labor necessary and the cost of the control program will vary from farm to farm. The method of clean-up may be different on each field of corn, depending on the way in which the corn was harvested and on the crop which is to follow corn. Cutting the corn for silage or fodder will entail more labor and cash cost than will husking in the field. It is doubtful whether, with present equipment, this method will be used unless the additional material can be utilized in feeding or for commercial purposes with a return sufficiently great to offset the additional cost. Plowing the stalk ground which is normally disked and preparing it for seeding will require about 2 hours more man labor per acre when a 2-plow tractor is used in plowing. It has been estimated that an acre of cornstalks may be broken, raked, and burned with 4.2 hours of man labor and 4.4 hours of horse labor if efficient labor and equipment are used. Shaving instead of breaking the stalks will increase this time slightly. On many farms this additional work can be done by the regular workers on the farm and therefore will require no additional cash outlay. Where considerable numbers of livestock must be cared for, extra labor must be hired.

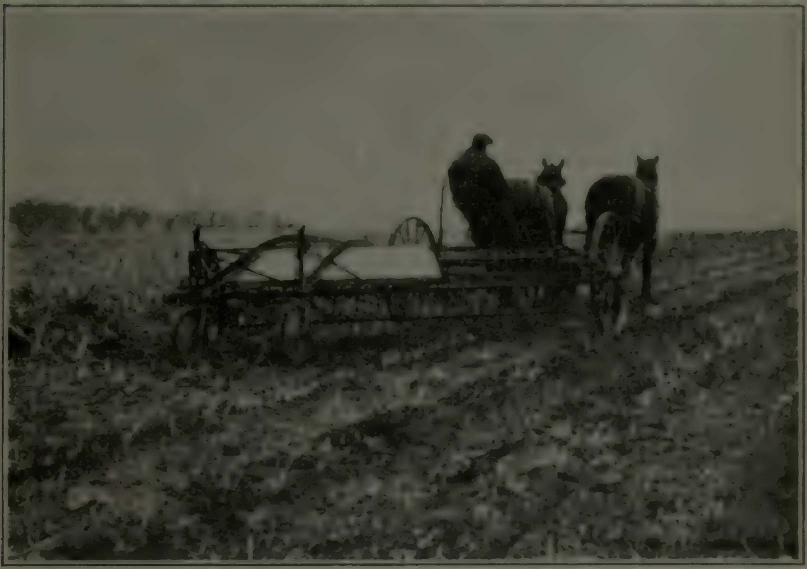


FIGURE 7.—Special stalk rakes with teeth close together or side-delivery rakes are most effective in this method of control

Development of new machinery for harvesting corn and for destroying the stalks in the field may prove an important factor in future corn-borer control. Although regular farm equipment may be used, if proper adjustments are made, purchase of some new equipment[5] may be justified. The standard corn binder will not cut the stalks low enough to give adequate control, but low-cutting attachments[6] which cut the stalks at the surface of the ground are now available. The field silage cutter, when equipped with a low-cutting attachment, is an effective control device and may prove practical on many farms. A special stalk rake, with teeth stronger and closer together, is more effective in raking stalks than the common hay rake. A low-cutting hand knife or hoe has also been devised, and a sled-type stalk shaver[7] for cutting the stalks before raking, may be made on the farm at small cost.

---

[5] Circular 132, Fighting the Corn Borer with Machinery in the Two-Generation Area.

Aside from using mechanical control measures, there seems little that the farm operator can do. No variety or strain of corn has been found which is immune to the borer.[8] Those characterized by large stalks, however, have shown greater tolerance to severe injury than those with small stalks.

A corn-borer-control calendar, giving a summary of methods that may be used under different conditions, the season when they may best be used under average conditions, and the equipment needed for most efficient work, is shown in Table 4.

TABLE 4.—*The corn-borer-control calendar*

Usual methods of harvesting corn and preparing ground for following crop	Possible methods of clean-up	Season when work should be done [1]	Equipment needed	Estimated [1] extra-man labor per acre
(1) Corn cut for fodder or silage; ground may be either plowed or disked.	Cut corn at ground surface, clean up and burn all stalks not eaten by livestock unless well trampled in manure.	Cut as early in the autumn as possible when more borers are in upper part of stalks. Stalks around feed lots should be burned before May 1.	Low-cutting attachment for binder or special hand knife or harvesting hoe if cut by hand.	Only that necessary in cleaning up around feed lots.
(2) Corn husked from standing stalks by machines or hand; ground plowed.	Plow 6 to 8 inches deep. Do not drag stalks to surface in subsequent operations.	As much as possible in fall and remainder before May 1.	16 or 18 inch plow, rolling coulters, jointers, and covering wires.	Only that caused by deeper plowing and making more careful adjustments.
(3) Corn husked from standing stalks by machine or hand; ground disked for following crop.	Same as in No. 2 if corn ground can be plowed.	Same as in No. 2	Same as in No. 2	1.4 hours with tractor or 2.5 hours with horses plus same as No. 2.
	If ground can not be plowed, break both ways, or shave; rake both ways and burn.	As much as possible during winter when frozen and dry. All before May 1.	Stalk shaver, or breaking iron, stalk rake.	4.2 hours.
(4) Corn hogged or pastured off.	Same as in Nos. 2 or 3.	Same as in Nos. 2 or 3.	Same as in Nos. 2 or 3.	

[1] Although clean-up work may be delayed until later than May 1, some margin of safety should be allowed for in the control program.

ADJUSTMENTS FOR CORN-BORER CONTROL

Economic and biological factors affecting farming are constantly changing, necessitating shifts in organization and operation. The coming of the European corn borer will undoubtedly necessitate such adjustments—growing some other crop in place of corn or adding the necessary control measures to the present farm operations. The farmer who meets these new conditions with the least additional cost or with the smallest reduction in income will be most sucessful under corn-borer conditions.

---

[6] Miscellaneous Publication 56, Low-cutting Devices for Harvesting Corn.

[7] Miscellaneous Publication 142, Construction of Sled-Type Cornstalk Shavers.

[8] Researches are being conducted by Federal and State agencies in efforts to find or develop varieties which are more resistant or less attractive to the borer than are existing varieties.

It is possible that oats and barley may be grown in place of a part of the corn in the Corn Belt, and substituted in the feeding program. But the decreased production of corn would result in its price increasing, and the higher price would be an incentive for growing as much corn as possible, especially in the cash-grain districts. Other cash crops apparently offer no real opportunity as substitutes for corn. The problem seems to resolve itself into a question of developing practices that will result in effective control of the borer so that the relative importance of corn in the rotation may be maintained. In the following pages the possibilities of adjusting the organization and operation of farms to meet corn-borer conditions by adding necessary control measures will be discussed. The amount and kind of equipment and the quantities of labor and power required under specific conditions will be estimated, as well as the actual money cost.

The organization on two farms—one a cash-grain farm and the other a livestock farm—will be used as examples in showing the possible adjustments in operation. The organization of these farms is typical of that on many successful farms in the important corn-growing regions. Consideration need be given only to those items of labor, power, and equipment required by the necessary added control measures and to those other changes following from such additions. It has not been thought necessary to compute farm earnings, either gross or net. It has been assumed that the addition of control measures will change the farm organization, the farm operation, and the subsequent farm earnings only in so far as noted in the bulletin.

It has been assumed that these farms are equipped to produce corn, hay, and small grain, as is the average Corn Belt farm. In estimating power and labor requirements it has been assumed that a tractor is used for plowing and that horses are used in all harvesting operations. The regular labor employed consists of the farm operator and a man hired by the month from March 15 to December 1. Other labor is hired by the day, as the necessity arises.

SUGGESTED ADJUSTMENTS FOR CORN-BORER CONTROL ON A GRAIN FARM

This is a 200-acre farm with the following acreages of crops and numbers of livestock:

	Acres		Head
Oats (clover)	45	Horses	7
Oats (clover	45	Cows	4
Winter wheat (clover)	45	Brood sows	4
Alfalfa	10	Pigs raised	30
		Hens	100
Total	190		

The crop rotation, or sequence, is (1) corn, (2) corn, (3) oats (with clover or sweetclover for green manure), (4) winter wheat (with clover or sweetclover for green manure). The alfalfa lot is renewed as the necessity arises.

The cropping system used on this farm is common in districts in which winter wheat is successfully grown. One-half the crop land in the regular rotation is in corn, the other half in small grains. A small field of alfalfa provides hay for the work stock and milk cows. If legumes are seeded in all small-grain crops and plowed under, the maintenance of maximum crop yields is assured. Sweetclover is usually preferred as a green-manure crop, but red clover is often used if difficulty in growing sweetclover is experienced. In many parts of the Corn Belt winter wheat is not always a sure crop. On farms on which this is true, a 2-year or 3-year rotation of corn and oats with a legume seeded in the oats and plowed under for corn (corn, oats and sweetclover) (corn, corn, oats and sweetclover) is more common. If more than one-half the crop land is given over to corn, the advisability of continuing such a rotation should be carefully considered before attempting to work out a control program. Ordinarily, if a substantial increase in crop yields can be secured by using a longer rotation including more sweetclover or other legumes, the farm income may be maintained or actually increased, control of the borer will be facilitated, and better use of labor and equipment will be obtained.

On this farm all grain is sold except that needed for the work stock and other livestock kept to supply the home with livestock products and to consume the farm wastes. Over 80 per cent of the total receipts is from the sale of crops. The usual practice is to plow the 45 acres of oat stubble for wheat as soon after threshing as is possible. About 30 acres of wheat stubble are fall plowed for corn. The remaining 15 acres of wheat stubble and 45 acres of stalk ground are then plowed for corn in the spring. The other 45 acres of stalk ground are disked and sown to oats, with no other preparation. All of the corn is husked from the standing stalks, since on a grain farm there is no opportunity for the feeding of silage or fodder.

Under usual conditions 45 acres of stalk ground are disked and seeded to oats, and the other 45 acres of stalks are plowed for corn. This means no heavy peak load of labor in the spring. On a grain farm like this there is not enough livestock to make much work, so there is ample time during the winter and early spring season to do a considerable amount of clean-up work without hiring extra labor.

Control of the corn borer may be secured most economically on this farm by using one of two methods: Plowing under all cornstalks for both corn and oats; or plowing for corn as usual, but raking and burning the stalks preparatory to disking for oats. The choice of these methods may be determined by the effect which plowing has on the yields obtained from the following crop, usually oats. Where soil conditions are such that spring plowing is impossible or is detrimental to the oat crop, then the method of raking and burning the stalks and disking for oats must be used. In the case of the stalk ground that is to be planted to corn again the only requirement for control is to use proper care and equipment in plowing in order to insure the complete covering of all stalks.

Assuming that the stalk ground can be plowed with no detrimental effect upon the oat crop, the plowing of the 45 acres, usually disked and seeded to oats, is estimated to require extra labor, power, and equipment as follows:

Man labor:	
Plowing, 45 acres	7 days.
Harrowing, 45 acres	3 do.
Tractor use, plowing	7 do.
Horse work, harrowing, four horses	3 do.
Fuel for tractor	120 gallons.
Oil for tractor	7 do.

Additional equipment (assuming a 2-plow tractor is used): Two large rolling coulters, two jointers, and two covering wires.

These figures are based on the supposition that if the stalk around is plowed for oats, the usual disking and an additional harrowing are also necessary before the oats are seeded. It is not believed that this additional work will present a serious problem. It can all be done by the regular labor force if a part of the usual plowing for corn is delayed until after the oat ground is ready for seeding. Figure 8 shows the estimated amount and distribution of man labor on livestock and crops, and the additional labor necessary with this method of control. Some other work usually done between oat seeding and corn planting, such as fence building and repair, and machinery and equipment repair, may have to be done during the winter months or later in the season, but the additional time necessary for control is small as compared with the total time used in crop production.

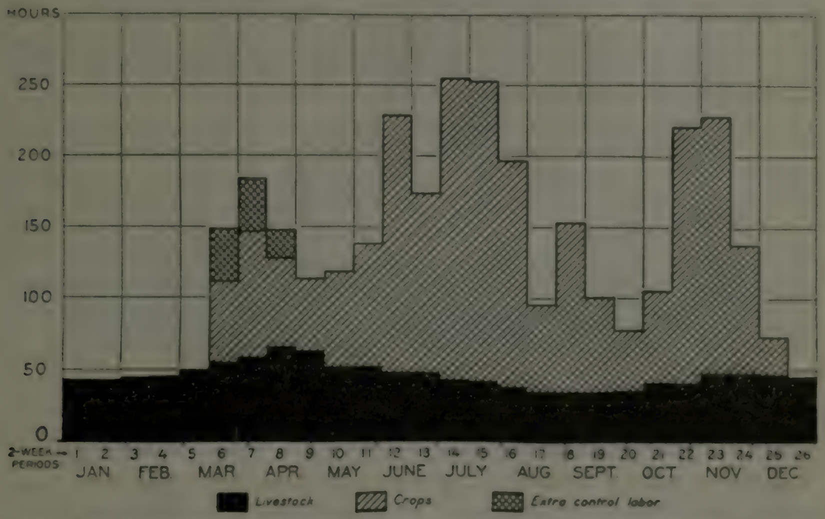


FIGURE 8.—DISTRIBUTION OF LABOR ON CROPS AND LIVESTOCK ON A 200-ACRE GRAIN FARM

Under this plan of control in which 45 acres of stalk ground are plowed for oats, the 10 days of additional work can be handled by the regular help.

The method of control as here outlined will have little effect on the farm earnings. It is estimated that the total additional cost, including that of materials purchased and depreciation on the additional equipment purchased, will be about as follows:

Fuel for tractor, 120 gallons at 14 cents	$16.80
Oil for tractor, 7 gallons at 75 cents	5.25
Depreciation	4.75
Total	26.80

Although the 10 days of additional work represent considerable effort, and on some farms it may be necessary to hire a part of it done in addition to that done by the regular labor, on this farm all of it is assumed to be performed with no additional cash outlay. Therefore this has no effect on the farm income. The same applies to the horse work. The added use of the tractor undoubtedly shortens the expected life of this machine, but it is not considered advisable to attempt here to estimate the small amount of depreciation. The fuel and oil used represent an actual money cost to the farmer. It is believed that the extra equipment needed can be obtained at a cost not in excess of $25 to $30. If the equipment is used over a period of several years, this expenditure is not excessive. The total reduction in farm earning due to the control measures is small and could be offset by a saving in yield of less than one-half bushel of corn on each of the 90 acres.

If the local situation is such that it is not considered advisable to plow the stalk ground for oats, the second plan of control must be adopted. Under this plan the stalks on the 45 acres intended for oat seeding will be cut or broken off at the ground surface, and raked and burned, preparatory to disking the ground and seeding it to oats. It will be necessary to break or shave the stalks and to rake the field both ways with a dump rake, or to follow the dump rake with a side-delivery rake, in order to do a complete job of gathering the stalks so they can be burned. Under this plan it is estimated that the following amounts of labor, power, and equipment will be required:

Man labor—breaking, raking, and burning 45 acres	27 days
Horse work—breaking, raking—2 horses	14 days

Additional equipment: Breaking iron or cutting sled, and stalk rake.

The large rolling coulters, jointers, and covering wires used under the first plan will be needed for plowing the 45 acres of stalk ground for corn.

Considering that this work can be done at any time after corn harvesting, it at first seems the most economical method. Weather conditions[9] in the Corn Belt, however, are such that 8 to 10 of the 27 days of labor would have to be hired to dispose of the stalks on the 45 acres. The stalks can be broken effectively only when the ground is frozen. Cutting, raking, and burning can be done only under favorable weather conditions. Since only the operator is on the farm at this season some extra help will be needed.

In such case the cost of this method of control would be about as follows:

Extra hired labor, 10 days	$24.50
Depreciation	11.50
Total	36.00

---

[9] The Weather and Climate of Chicago. During the period 1871 to 1913 only 23 days on an average were clear during January, February, and March; 31 days were partly cloudy; and 36 days were cloudy. Rainfall was recorded on an average of 34 days and snow fell on 15 days. A mean temperature below freezing was recorded on an average of only 33 days.

The equipment necessary, in addition to that needed in plowing, a breaking or shaving tool and stalk rake, should be bought for $50 to $75. The cost of labor, figured here at 35 cents per hour, will vary somewhat in different districts, as will the amount of labor available. Although the estimated cost is greater under this plan than if the ground were plowed for oats, the clean-up work is all done before the regular spring field work begins (fig. 9), and no further adjustment in the usual plan of operation need be made.

It is obvious that if the control measures suggested in the above plans prevent even a small reduction in the yield of corn, their additional cost is more than justified. The cost of control, as measured by the reduction in farm incomes, will be greater on farms on which a larger percentage of the crop land is in corn, or on which no fall-seeded crop is produced, as with the 3-year rotation of corn, corn, and oats. Here the spring labor is usually heavy and less time is available for the additional work demanded by the control measures. Under these circumstances a larger portion of this additional work must be performed by extra hired labor. On such a farm growing soybeans in place of a part of the usual oat crop may prove of value in reducing the amount of extra labor necessary and may be a profitable change. Although the labor on soybeans conflicts with that on corn (fig. 4) and plowing is necessary in place of disking, the later date at which soybeans may be seeded would give more time for the necessary labor on control work. In many districts wheat is sown on the soybean ground with little seed-bed preparation and may take the place of oats in the rotation, thus further reducing the spring-labor demand and providing a crop with an acre value usually higher than that of oats.

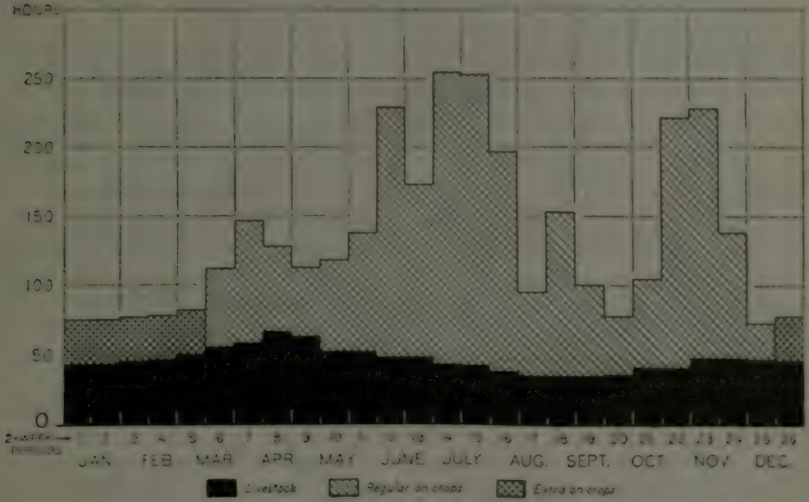


FIGURE 9.—DISTRIBUTION OF LABOR ON CROPS AND LIVESTOCK ON A 200-ACRE GRAIN FARM

Under this plan of control in which the stalks on 45 acres are raked and burned, and the ground is disked for oats, about 10 days of extra labor must be hired.

SUGGESTED ADJUSTMENTS FOR CORN-BORER CONTROL ON A LIVESTOCK FARM

This is a 200-acre farm with the following acreages of crops and numbers of livestock:

	Acres
Corn	68
Oats	34
Wheat	34
Clover hay	17
Clover pasture	17
Alfalfa	10
Total	180

	Head
Horses	4
Cows	4
Steers fed	20
Brood sows	15
Pigs raised	125
Hens	200

A 5-year rotation is used: (1) Corn, (2) corn, (3) oats, (4) wheat, (5) clover, and normally provides a balance between crop production and livestock kept.

Livestock (principally beef cattle and hogs) is the important source of income on this farm, 80 per cent of the annual receipts being derived from the sale of livestock and livestock products. Only the wheat and a small part of the oats are sold. All of the corn and most of the oats are fed, and supplementary feeds necessary in balancing the rations are bought. Any change in the cropping system, which lowers the production of feed, tends to disturb this balance between feed production and numbers of livestock, an unimportant item on the grain farm. On the other hand, profitable use of the entire corn plant as silage or fodder may be made on the livestock farm, a possibility not often existing on the grain farm.

The cropping system on this farm, with 40 per cent of the rotated crop land in corn, 40 per cent in small grain, and 20 per cent in hay and pasture, is one commonly used in those parts of the Corn Belt in which the maintenance of soil fertility is an important factor and livestock is the principal source of income. Common variations of this system are a 4-year plan of corn, corn, oats, and clover, used where wheat is not a sure crop, and the 4-year rotation of corn, oats and wheat, and clover, used where a part of the corn is cut for silage or fodder. The corn-stubble ground is disked and sown to wheat where this plan is used.

In the usual plan of operation as outlined for this farm about one-half the clover, or 17 acres, is cut for hay, and the remainder is used for hog pasture. The first-year clover in the wheat stubble also furnishes pasture after threshing, if needed. The 34 acres of oat stubble are plowed for wheat as soon after threshing as soil conditions will permit. After wheat sowing, the 34 acres of clover sod are usually plowed for corn. In the spring 34 acres of stalk ground are disked and seeded to oats and the remaining 34 acres of stalk ground are usually plowed for corn. It has been assumed here that all corn is husked by hand in the field, although on many farms a small acreage is often hogged off. This would make little difference in deciding on a method of control.

With this rotation, in which only 40 per cent of the crop land is in corn and in which the clover sod is fall plowed for corn, the spring field work normally is not heavy. The greatest peak load of labor comes during corn cultivation, hay harvest, and small-grain harvest. Extra labor is often necessary during this season. It must be remembered, however, that on this farm the time available during the early spring for labor on crops is much less than that on farms on which little livestock is kept. This means that a larger part of any extra work due to corn-borer control measures must be done by extra hired labor than is necessary on grain farms.

The same methods of control outlined for use on a grain farm are applicable on farms on which livestock is more important. The possibilities of making profitable changes in the cropping systems are more limited on well-organized farms on which there is a balance between feed and livestock production, but changes in the method of harvesting the corn crop can often be made without disturbing this relation.

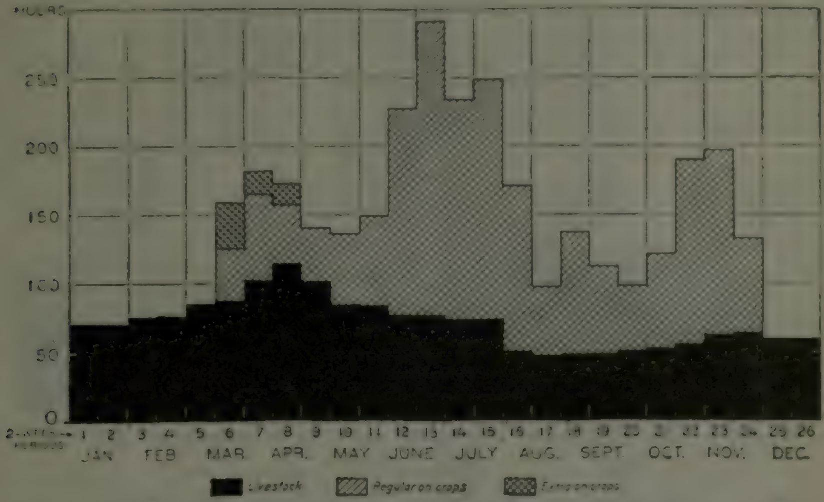


FIGURE 10.—DISTRIBUTION OF LABOR ON CROPS AND LIVESTOCK ON A 200-ACRE LIVESTOCK FARM

Under this plan of control in which 34 acres of stalk ground are plowed for oats, the eight days of additional work can be handled by the regular help.

Assuming, in considering a first plan of control, that the stalk ground can be plowed for oats with no serious difficulties, about eight days of additional work would be necessary in preparing the 34 acres for seeding. The estimated amounts of labor, power, and equipment necessary under this method of control are as follows:

Man labor:	
Plowing, 34 acres	6 days.
Harrowing, 34 acres	2 do.
Tractor use, plowing	6 do.
Horse work, harrowing, 4 horses	2 do.
Fuel for tractor	92 gallons.
Oil for tractor	5½ do.
Additional equipment: Two large rolling coulters, the jointers, and two covering wires.	

Under this plan the distribution of labor on this farm would be about as shown in Figure 10. The additional work is all done during the usual time for preparing the ground for spring seeding, and although greater effort is required of the regular help it is not necessary to hire additional labor. It may be necessary to shift other less important operations from one time to another.

The actual cost to the operator, then, is only that of fuel and oil for the tractor in plowing and of depreciation on the equipment necessary in control work. This is estimated to be about as follows:

Fuel for tractor, 92 gallons at 14 cents	$12.88
Oil for tractor, $5\frac{1}{2}$ gallons at 75 cents	4.12
Depreciation on equipment	4.75
Total	21.75

While under the first plan the 34 acres of stalk ground may be plowed for oats with no additional hired labor, if as a second plan it becomes necessary to rake and burn these stalks, this additional work probably will have to be done by extra hired labor. The additional amounts of labor, power, and equipment necessary when this method is adopted are estimated to be as follows:

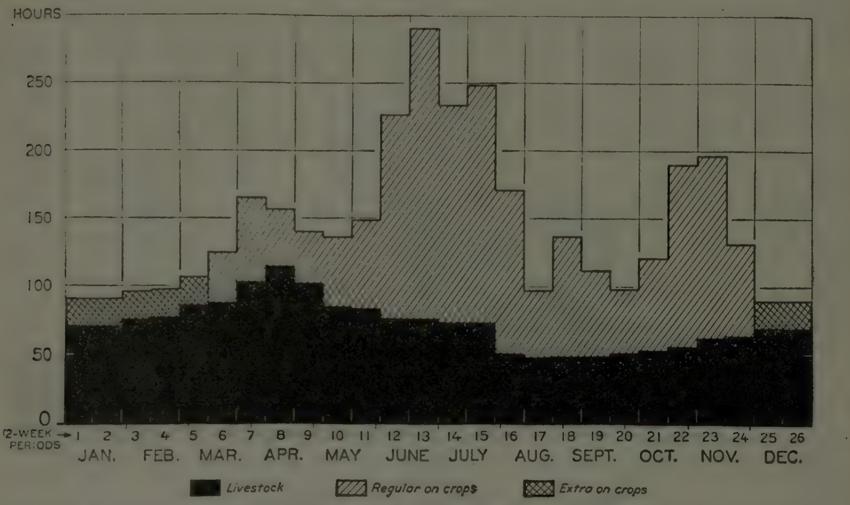


FIGURE 11.—DISTRIBUTION OF LABOR ON CROPS AND LIVESTOCK ON A 200-ACRE LIVESTOCK FARM

Under this plan of control in which the stalks on 34 acres are raked and burned and the ground disked for oats, about 21 days of extra labor must be hired.

	Days
Man labor—breaking, raking, burning, 34 acres	21
Horse work—breaking, raking—2 horses	11

Additional equipment: Breaking iron or cutting sled, and stalk rake.

The large rolling coulters, jointers, and covering wires used in the first plan will also be needed for plowing the 34 acres of stalk ground for corn. As is shown in Figure 11, this extra work all comes at a time when the operator is alone on the farm and when livestock requires the greatest amount of time. Raking and burning, if completed before oat seeding, must be done when weather permits during the winter and early spring. The extra cost of clean-up with this method is therefore greater than where the stalk ground is plowed for oats and is also greater per acre than on the grain farm where a greater part of the additional work can be done by the operator himself. This extra cost is estimated as follows:

Man labor, 21 days	$50.00
Depreciation on equipment	11.50
Total	61.50

On the basis of the foregoing estimates the cost per acre of controlling the corn borer is higher on livestock farms than on grain farms. The same equipment and methods of control are used on each, but because of the competition of livestock for the operator's time a greater part of the control work must be done by extra hired labor. Although the additional work, if performed by the regular labor, putting in more hours, has no effect on the farm earnings, as commonly calculated, the cost of labor hired in addition to the regular labor represents a cash expense that actually decreases the farm earnings.

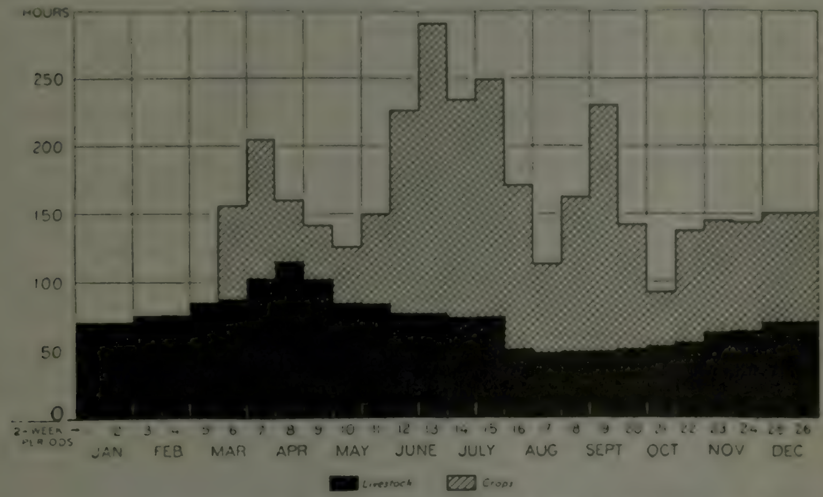


FIGURE 12.—DISTRIBUTION OF LABOR ON CROPS AND LIVESTOCK ON A 200-ACRE LIVESTOCK FARM

If 34 acres of corn are cut—10 for silage and 24 for fodder—and if 34 acres of stalk ground are plowed for oats, more labor is required in harvesting the corn crop but little extra labor is necessary in controlling the corn borer.

If the livestock organization is such that changes may be made in the methods of harvesting the corn crop, and more of the corn fed as silage or fodder, a rotation of corn, oats, corn, wheat, and clover would give the same quantity of feed grain as is now produced. Under this plan, 34 acres of corn are cut—10 acres for silage and 24 acres for fodder. The wheat is then drilled into the corn-stubble ground without plowing. The oat-stubble ground and possibly a part of the clover sod may be fall plowed for corn, leaving only the 34 acres of stalk ground to be cleaned up for oats in the spring.

The estimated labor distribution where this cropping system is used is shown in Figure 12. Under this plan more labor is necessary in harvesting the corn crop than if the corn were husked in the field, but the additional work comes during a season when no labor is required on other crops. An additional month of hired labor may be necessary in the fall to husk the corn from the shock, and the added investment in a silo and silo-filling machinery will increase the cost of operating the farm. Unless this additional outlay can be offset by a decrease in expense for other feed, or by increased sales of grain or livestock, the economic advisability of this method of control may be questioned. Cutting the corn for silage or fodder merely to control the borer can hardly be justified in view of the alternative methods of control open to the farmer.

FACTORS AFFECTING COST OF CONTROL

The quantities of labor and materials required for each method of control on the two farms used as examples were estimated on the basis of specified conditions. The local physical and economic situation confronting an individual farmer, however, may greatly vary the necessary quantities and their costs. In planning a control program for the individual farm and in estimating its probable cost, these local conditions must be taken into consideration.

The additional labor required of the regular labor force in developing a program of corn-borer control in many cases will mean an adjustment in the spring program of work. On many farms this program is not full, on others it is very full. It is not assumed that the farmer is ever idle during this period, but that, by making the necessary shifts during a time when labor demands are ordinarily less pressing than later, he can, without serious consequences, introduce into his program of work this extra effort demanded of his regular labor force.

In estimating the quantities of labor required on the farms used as examples it was assumed that sufficient care was taken in plowing and in raking and burning to obtain effective control of the borer. Under unusual conditions, or on farms without proper equipment for performing the suggested control work effectively, it may be advisable to rake and burn the stalks, and also to plow for both corn and oats. A saving of 2½ bushels in the yield per acre on the livestock farm would offset the cost of this extra precaution.

It was also assumed that plowing was done with a 2-plow tractor, and that horses were used in the lighter field operations. If no tractor is available for plowing, the quantity of extra work will be greater and more extra hired labor will become necessary, thus increasing the cost of control. The use of larger machinery in the regular field operations will decrease the amount of extra work necessary in control measures. Still more important is the development of new and more efficient machinery in cleaning up and destroying the cornstalks. Such machinery will make control work even more effective and will require less additional effort than at present.

It is to be recognized that some damage to the corn crop may develop under severe infestation even with the most careful clean-up program. The extent of damage under these conditions, however, will be far less if an effective control program is used than if all control measures are omitted. The cost of even the most detailed and carefully executed control program will be small in comparison with the loss that may occur without it. This fact seems sufficient reason why every Corn Belt farmer should have in mind a thorough clean-up plan which may be put into his farming program when the necessity arises.

U. S. GOVERNMENT PRINTING OFFICE: 1932

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1682

USEFULNESS OF BIRDS ON THE FARM

BIRDS have long been protected for the charm of their songs and their interesting habits. They also deserve careful fostering by man because of their decided economic usefulness.

The economic value of birds is most evident on the farm and it should be most appreciated there. Birds thread their way through garden and field crops, inspect the orchards, explore ornamental shrubbery, and clamber over saplings and trees of the wood lot, gleaning insects wherever they go. Many of these insects are so destructive that the farmer, in his constant fight for pest control, should regard the feathered allies as among his greatest friends.

Protection of the birds should be almost instinctive on the part of the farmer. If, in addition to protecting them, he will give a little attention to improving their nesting facilities and insuring a water supply, he can increase the avian population on his place several fold. He will be repaid not only by the birds' services as insect destroyers, but also by the sprightliness of their presence and the melody of their songs. Aside from the general rural picture of pleasing vegetation, birds—posing, preening, flying, calling, singing—add more to our enjoyment of the countryside than do any other living things.

Washington, D. C. December, 1931

USEFULNESS OF BIRDS ON THE FARM

By W. L. McAtee, *Principal Biologist, in Charge Division of Food Habits Research, Bureau of Biological Survey*

CONTENTS

	Page
Introduction	1
Combined attacks on pests	1
Daily warfare on insects	4
Our bird population	4
Upland game birds	4
Birds of prey	5
Cuckoos and woodpeckers	7
Nighthawks and humming birds	8
Our bird population—Continued.	
Flycatchers	8
Jays, crows, and ravens	9
Blackbirds	9
Sparrows	9
Other insect eaters	9
Public attitude toward birds	13

INTRODUCTION

IF FARM LABORERS should offer to make their principal job the killing of insects and other crop pests, asking nothing in return but their board and lodging, farmers would accept the offer with enthusiasm. Yet those most persistent and voracious insect destroyers, the birds, in as large numbers as the farm will accommodate, offer their services on just such terms—and in many cases the farmer does nothing about it. A little protection and a little attention to nesting facilities and water supplies are all that is needed to increase the numbers of these natural pest destroyers. If the supply of wild-fruit food is maintained, about all else that the bird laborers will require for board will be a moderate toll of a few crops, which, in view of services rendered, can well be paid.

The general usefulness of birds in destroying insects is something about which the good observer has no doubt. In an orchard, during the nesting season, he will see the birds active in every direction. Flickers, blackbirds, robins, and thrashers seek their insect prey on or near the ground; woodpeckers, nuthatches, titmice, and chickadees closely search the trunks and limbs of trees; vireos and warblers scan the leaves and probe the flowers; and flycatchers and swallows sweep their prey from the air itself. Every few minutes all day long the hungry young must be fed; and that they are well fed their rapid growth attests. The quantity of insects they and their parents consume is enormous. Not only do orchards benefit by the good work of birds, but gardens, berry patches, and plowed and newly sown fields as well. Though fields actually grown to tall crops are less freely visited, all crops are helped to some extent, and most farm pests have their bird enemies.

COMBINED ATTACKS ON PESTS

To understand the economic value of birds, not only must the feeding habits of species and families be known, but also the collective effect of birds upon pests and crops. Most of the damage they do results from local overabundance, either of one species or of a number of species of similar feeding habits, and it is inflicted chiefly upon fruit and grain crops. The produce of small numbers of fruit trees especially is liable to severe damage where there is an abundance of fruit-eating birds. In orchards of commercial size damage is less often noticed. Preventive measures are of some avail; but aggressive action is sometimes necessary against birds that persistently destroy fruit crops or grain. Grainfields are seldom severely damaged by birds under modern conditions, except on lands near breeding grounds of bird colonies, populous roosts, or in the migration route of gregarious species. The blackbirds are the most notorious offenders in this respect, and flocks of them at times are so large that it seems there must be a blackbird for every plant in the grainfield.

If birds by their united effort can accomplish great harm, they are for the same reason able to do great good in the destruction of insect pests. Fortunately there are many more helpful than harmful species. Unusual outbreaks of pests upon which birds can feed are always attended by gatherings of the bird clans. In no instance has this been more evident than in the field-mouse plague that occurred in the Humboldt River region of Nevada in 1907–8, during which the damage to crops was placed at $250,000 in a season. Gulls, hawks, and owls flocked to the scene, and all birds able to live upon mice took practically no other food. The birds, it was estimated, destroyed about 900,000 of these field mice each month during the infestation.

The way in which birds concentrate when an outbreak of an injurious insect occurs is illustrated in the case of the alfalfa weevil, a destructive pest accidentally introduced into the region about Great Salt Lake. In two summer's investigations in Utah, 45 species of birds were found to attack the weevil. The killdeer was one of the most active of these, making alfalfa weevils a third of its food during part of the summer; one stomach contained no fewer than 383 individuals, 376 in the larval stage. The record for numbers—442 in one stomach (fig. 1)—was held by Brewer's blackbird, an abundant species in Utah. A surprising discovery was that as a species the English sparrow was the most effective enemy of this insect; alfalfa weevils formed about a third of the food upon which its young were reared, and it was estimated that the number fed to growing English sparrows on a typical Utah farm was about 500,000. To this must be added the number eaten by the adult sparrows, which made of them about a fifth of their food. Most of the common birds of northeastern Utah were depending upon alfalfa weevils for almost a sixth of their entire food, and the destruction of these pests by this warfare is almost beyond conception.

The good work of birds in preying upon another weevil pest, the cotton-boll weevil, must not be overlooked. Sixty-six kinds of birds are known to feed upon this formidable cotton destroyer, probably the most effective being the orioles, which actually remove the boll weevils from the place where damage begins—that is, the squares, or flower buds, of the cotton plants—and the swallows, which feed upon weevils that are in flight. In the stomach of one Bullock's oriole there were found as many as 41 boll weevils, and large numbers are habitually taken by all species of swallows; every one of a series of 35 eaves swallows had eaten them, the largest number in any stomach being 48, and the average 19.

Another serious agricultural pest that is freely eaten by birds is the wheat aphis, or green bug. On a 200-acre farm in North Carolina, where wheat, rye, and oats were severely attacked by green bugs, it was found that birds were very effective in destroying the pests. The outbreak was at its height during the migration season of such birds as the goldfinch and the vesper and chipping sparrows, which with other species on the farm numbered more than 3,000 individuals. It was found that these birds were destroying green bugs at the rate of nearly a million a day, and on days when additional flocks of migrants were present this destruction was doubled. During the season such numbers of birds flocked to the grain fields that the aphis infestation was reduced by an incalculable number.

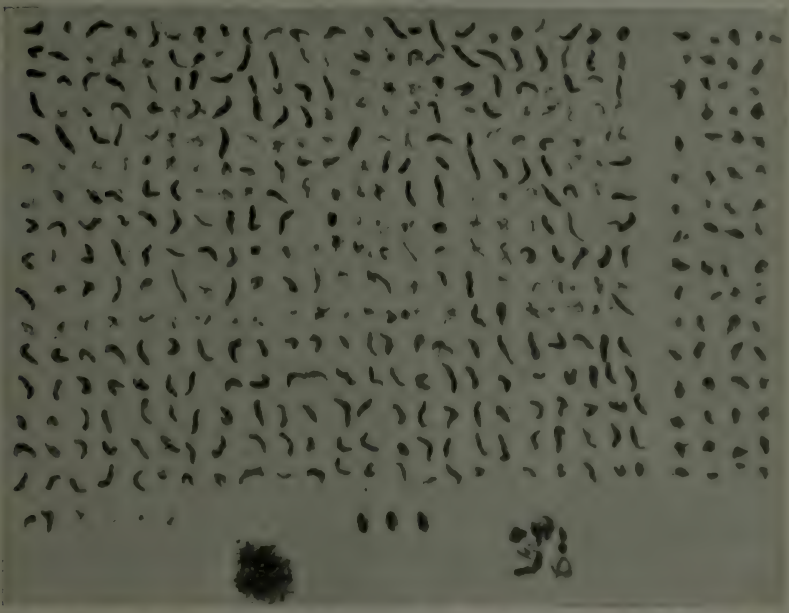


FIGURE 1.—One meal of a Brewer's blackbird. The graphic record of a single bird for destruction of alfalfa weevils. These injurious insects formed 96 per cent of the food of this individual and numbered 442, chiefly in the larval stage; three adult weevils and remains of other insects in the stomach are shown at the bottom of the picture

A classic instance of the concentration of bird attack upon an army of insect invaders occurred during the severe outbreaks of the Rocky Mountain locusts between 1865 and 1877. So numerous were these voracious pests that many places they visited were denuded of every green thing. A thorough investigation was made of the relation of birds to the outbreak, and it was found that practically every species, from the largest birds of prey to the tiny hummingbirds, from ducks and other aquatic fowl to typical bird denizens of the dry plains, turned to feeding upon locusts. In fact, most birds gorged themselves with this abundant supply of food, and in so doing were the means in numerous cases of saving crops from destruction.

DAILY WARFARE ON INSECTS

Conspicuous and important as are the activities of birds in gathering at the scene and taking part in the suppression of insect outbreaks, probably their every-day services in consuming insects of all kinds, thus holding down the whole tide of insect life, are of greater significance. No one who has observed the ceaseless activity of birds in feeding their young can doubt that the destruction of insects in this way is enormous. The house wren brings food to its young about once every two minutes all day long. Not many birds equal this record. Probably one feeding every five to eight minutes is the average rate. Only the insects' enormous powers of reproduction enable them to survive the terrific warfare waged when all the parent birds are foraging on ground, grass, trunks, branches, and foliage, to feed their nestlings.

Not only in the nesting season but all through the year, the birds carry on an intense predatory campaign against the insects. Hardly an agricultural pest exists but has numerous effective bird enemies. The numbers of species of birds known to feed on certain prominent insect pests are given in the following list:

Alfalfa weevil	50
Army worm	43
Billbugs	110
Brown-tail moth	31
Chestnut weevils	85
Chinch bug	29
Clover-root borer	94
Clover weevil	48
Codling moth	36
Cotton-boll weevil	66
Cotton worm	41
Cutworms	98
Forest tent caterpillar	32
Gypsy moth	46
Horseflies	49
Leaf hoppers	175
Orchard tent caterpillar	43
Potato beetle	34
Rice weevil	22
Spotted cucumber beetle	42
White grubs	95
Wireworms	205

OUR BIRD POPULATION

In the United States are found more than 800 distinct kinds of birds of 75 families, 22 families of which are classed as water birds, 7 as shore birds, 5 as upland game birds, 5 as birds of prey, and 36 as land birds. In general, the smaller land birds are of greatest interest to the farmer and orchardist. Of the larger birds, however, the upland game birds, the hawks, and the owls deserve notice.

UPLAND GAME BIRDS

The upland game birds comprise such familiar groups as quail, grouse, introduced partridges and pheasants, and wild pigeons and doves. Quail have rarely been charged with damaging crops, but the ruffed grouse sometimes eats buds of apple trees to an injurious extent; pheasants occasionally eat corn, peas, tomatoes, and other crops more than is to the liking of individual farmers; the band-tailed pigeons of the West may devour fruits to excess; and mourning doves in some localities feed upon sprouting seeds of farm crops. All these game birds except the doves and pigeons do some good in consuming insect pests; all are of value to the farmer by making his land attractive for hunting, a privilege that he can dispose of for profit if he desires; and, finally, because they are valuable as food species and are eagerly shot for sport, all can be quickly reduced in numbers whenever that course proves necessary.

BIRDS OF PREY

The birds of prey include the carrion-feeding vultures, the fiercely rapacious hawks and eagles, the fish-loving osprey, and owls of various habits. The vultures, of which the familiar black and turkey buzzards are examples, are carrion feeders and will disappear from communities where all offal is properly disposed of, but in some localities they still have plenty of work to do. The charge that they are instrumental in distributing hog cholera and other livestock diseases is based chiefly on suspicion. It is not true that they disseminate the germs of these diseases in their droppings, and the fact seems to be that buzzards, if a factor in spreading stock ills, are a minor one.

Hawks and owls, though not closely related, may be considered together on account of the similarity of their feeding habits. Feeding chiefly upon living animals smaller than themselves, they naturally prey sometimes upon some of the domesticated kinds, particularly poultry. This has given them a bad reputation with farmers, so long established as to amount to traditional prejudice. Scientific investigation of their habits shows that only a few species of hawks and only one owl feed chiefly, or even largely, upon birds, and therefore to any great extent upon poultry. The birds of prey correctly regarded as chiefly injurious include the sharp-shinned, Cooper's, and duck hawks, the goshawk, and the great horned owl. The bird hawks fly swiftly over trees and bushes and make sudden darts upon their prey, and from this behavior and their color, three of the species are often known as blue darters. The hawks that are chiefly beneficial differ in flight from the darting hawks, either soaring at a considerable height or hovering over places where they are seeking prey. The great horned owl, which, like most of its relatives, feeds at night, can capture only poultry that has not been properly protected. When prevented from doing this, the horned owl is largely beneficial rather than injurious.

The remaining species of hawks and owls, more than 50 in all, have useful habits. They feed on a great variety of rodents and have a tremendous effect in controlling the numbers of these pests. Their staple food consists for the most part of meadow mice, but it includes also many other destructive rodents, such as rabbits, ground squirrels, prairie dogs, pocket gophers, and house rats and mice. The barn owl (fig. 2) is one of the most useful birds of this group. Its food is easily studied by examining the pellets, made of the hair and bones of its victims, which accumulate about its roost. These indigestibles are ejected habitually by all birds of prey, but are scattered too widely for collection and study except by species having restricted roosting sites.

In 675 barn-owl pellets collected in Washington, D. C., were found the remains of 1,119 meadow mice, 452 house mice, and 134 house rats, together with a sufficient number of other small mammals to make an average of almost 3 to the pellet, and probably to the meal.

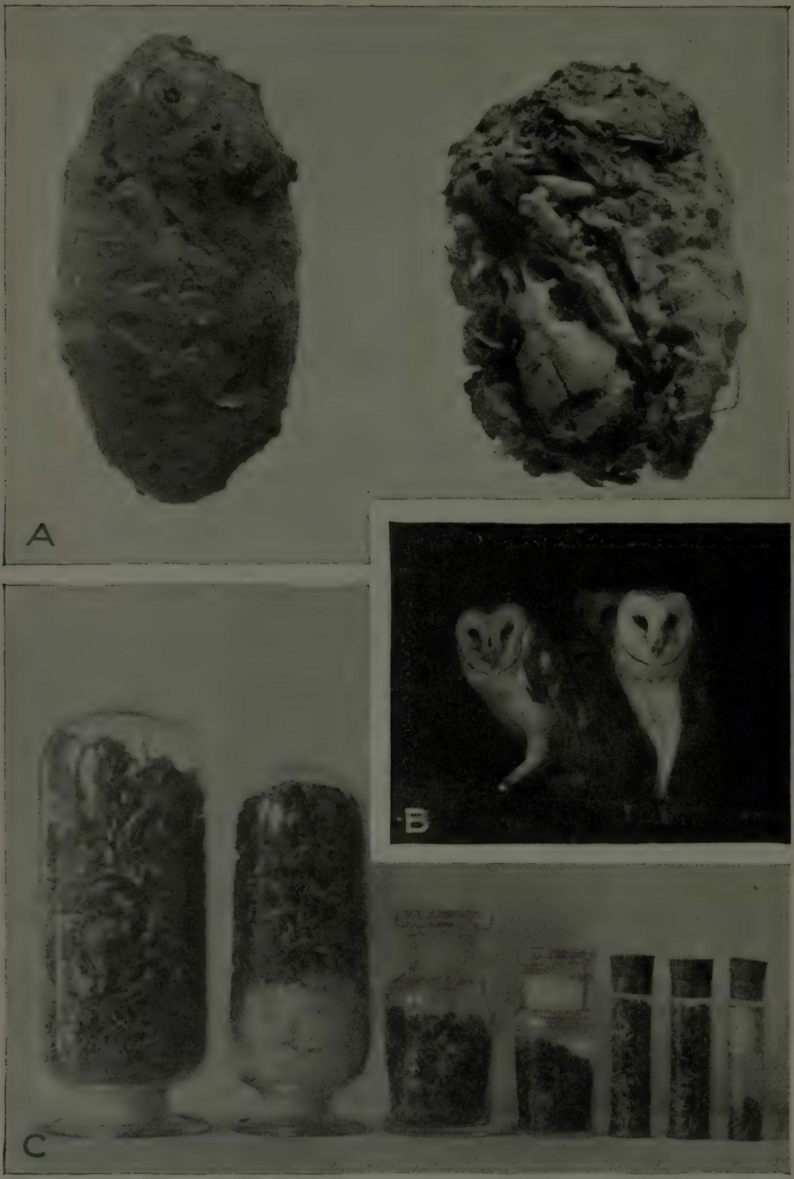


FIGURE 2.—The barn owl and its food: A, Barn-owl pellets, indigestible portions of the food rolled up and ejected; these are often an inch in diameter, and 2 to 2½ inches long. B, barn owls in their roost; C, contents of 592 pellets investigated—1,058 skulls of pocket gophers, rats, and mice. Most owls are valuable aids to the farmer by their destruction of numerous harmful small animals

In 592 pellets collected in California were found skulls and other traces of 261 pocket gophers, 74 field mice, 184 pocket mice, 144 deer mice, 50 harvest mice, 230 kangaroo rats, and 215 house mice.

These items make it clear that the barn owl is constantly doing work of great value to agriculture. Its services are typical of those of hawks and owls in general. Owls as a group have long been persecuted by man, but never has persecution been more unjust. However, the hawks and owls are not the only sufferers, for when their numbers are greatly reduced in any community, farmers will be forcibly reminded of the fact by a great increase in the number of destructive rodents.

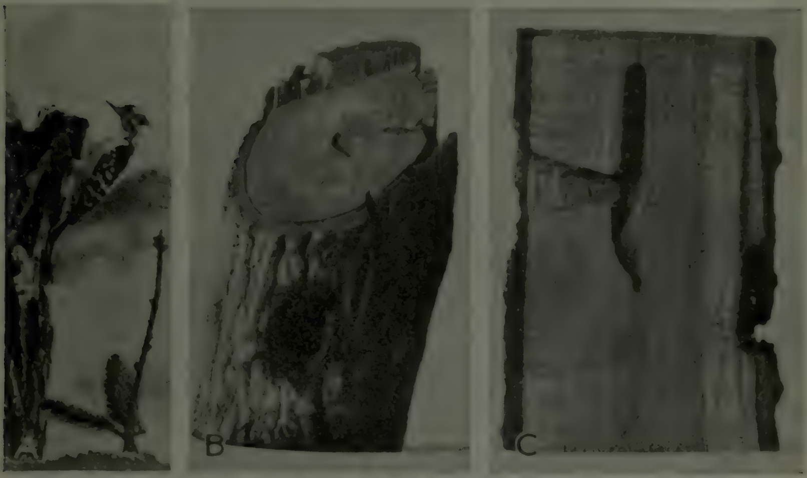


FIGURE 3.—The woodpecker and its helpful work: A, Hairy woodpecker, one of the 24 species of birds of this large family, most of which are highly beneficial (photo by C. F. Stone); B and C, examples of work of woodpeckers; their bills are specially fitted to dig out wood-boring larvae from deep in the trees

CUCKOOS AND WOODPECKERS

Though many of the birds of prey, game birds, and wild fowl have distinct economic value, one must turn to the characteristic land birds to find whole families that are almost uniformly beneficial and for large numbers of species practically perfect from the economic point of view. Among the most praiseworthy birds are the cuckoos. The most widely distributed species, the yellow-billed and black-billed cuckoos, usually keep out of sight, but are well known by their strange notes. As these are thought to be given most freely before rains, the birds are frequently called "rain crows." The cuckoos feed very largely on caterpillars, and more than most other birds, on the hairy and spiny kinds. One stomach contained 250 tent caterpillars and another 217 fall webworms. The cuckoos are fond also of grasshoppers, sawfly larvae, plant bugs, and other injurious insects.

The largest and important woodpecker family includes 24 species in the United States, most of them highly beneficial. They are the chief defenders of trees against insect attack, most of them being specialized to feed upon wood-boring larvae, pests preyed upon by few other birds. (Fig. 3, c.) From a third to two-thirds of the entire food of several species consists of wood-boring insects. From 10 to 80 per cent of the annual diet of various species is made up of ants, which are almost uniformly injurious. The flickers, or yellowhammers, especially are assiduous destroyers of ants, one of these birds being known to have taken more than 5,000 at a single meal.

NIGHTHAWKS AND HUMMING BIRDS

A group of birds the members of which, though diverse in appearance, are related in essential characters, includes the chuck-will's-widows, whippoorwills, poowills, nighthawks, swifts, and humming birds. All are almost strictly insect eaters and consequently beneficial. The larger ones feed extensively upon leafchafers, the larvae of which, including the well-known white grubs, are very destructive. The nighthawks (fig. 4) take considerable of the same sort of food, but, in common with the swifts, capture a great variety of small insects, more than 50 different kinds having been found in single stomachs, represented in some cases by thousands of individuals. The humming birds devour minute insects, which they find in flowers or catch on the wing, and do not subsist to so large an extent as ordinarily supposed upon the nectar of flowers.

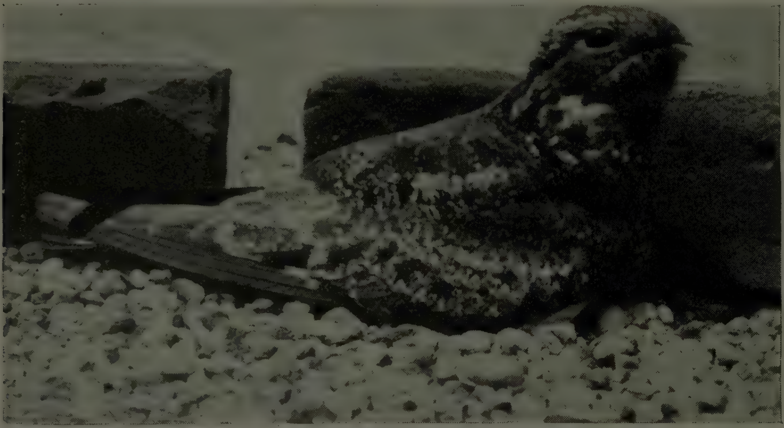


FIGURE 4.—The nighthawk, an extremely valuable insect destroyer. This bird, often wantonly shot, scoops its prey out of the air, and more than 50 different kinds of insects, represented by thousands of individuals, have been found in single nighthawk stomachs. (Photograph by Lewis F. Hall)

FLYCATCHERS

One family of birds gets its popular name, flycatcher, from its insect-eating habit. Among the 31 members of the flycatcher family living in the United States are such birds as the spectacular scissortail, the bold, dashing kingbird, and the more quiet and domestic phoebe. An average of 95 per cent of the food of these birds has been found to consist of insects. The rose chafer, a species of insect not only destructive to vegetation, but known to be poisonous to chickens and pheasants, is freely eaten by the kingbird. Several flycatchers have the reputation of eating honeybees to an injurious extent, but it has been shown that they take mostly drones, and furthermore, that they kill enough enemies of the bees, like robber flies, to pay for all the domestic bees they take.

JAYS, CROWS, AND RAVENS

Jays, crows, and ravens have always been severely criticized, and it must be admitted that on the whole the criticism is justified. About the best that can be said for birds of this family is that on an average they do about as much good as harm. It would seem a good policy to accord them all the same treatment long given the common crow—the crow is not especially persecuted, neither is it protected. Thus, while the birds are allowed to exist in reasonable numbers for the sake of the good they do, the way is left open for aggressive measures against them when necessary. In the case of this family, as of all destructive birds, damage usually is the result of overabundance.

BLACKBIRDS

The damage done by the blackbirds is conspicuously the result of overpopulation. One of the most characteristic habits of these birds is flocking, and some of their gatherings are enormous. In their winter home along the Gulf coast flocks of blackbirds at a distance look like great clouds or rolling balls of dense smoke. Fortunately, at the time when these birds are assembled in these armies there is nothing for them to damage, and their flocks are much smaller at the season when grain from the milk stage to maturity is exposed to their attack. Nevertheless, the damage sometimes is serious, and protection of these species is not recommended. In the same family with the blackbirds, however, are such birds as orioles and meadow larks, and these do much more good than harm.

SPARROWS

The great sparrow family, comprising almost a hundred species in the United States, as a whole shows a good economic record. The introduced English sparrow, usually a nuisance and often injurious, is, it must be remembered, but one of this large family, and its habits are by no means characteristic of the native species. The sparrows, or finches, are essentially seed eaters, but they consume also a fair proportion of insects, and in general must be regarded as beneficial. Certain species at times take too many birds, and a few others occasionally damage grain, but these practices are exceptions that may be met by local control.

OTHER INSECT EATERS

The tanagers and swallows (fig. 5) are almost exclusively beneficial, the latter especially being tireless destroyers of a great variety for insects. They course systematically over fields and gardens, over land and water, and gather up untold numbers of the small pests that are a constant menace to our comfort and prosperity.

If soft plumage and harmonious colors were the criteria of bird worth, the cedar waxwing would stand near the top. Economically, however, it is in the doubtful, even the very doubtful, class. It is

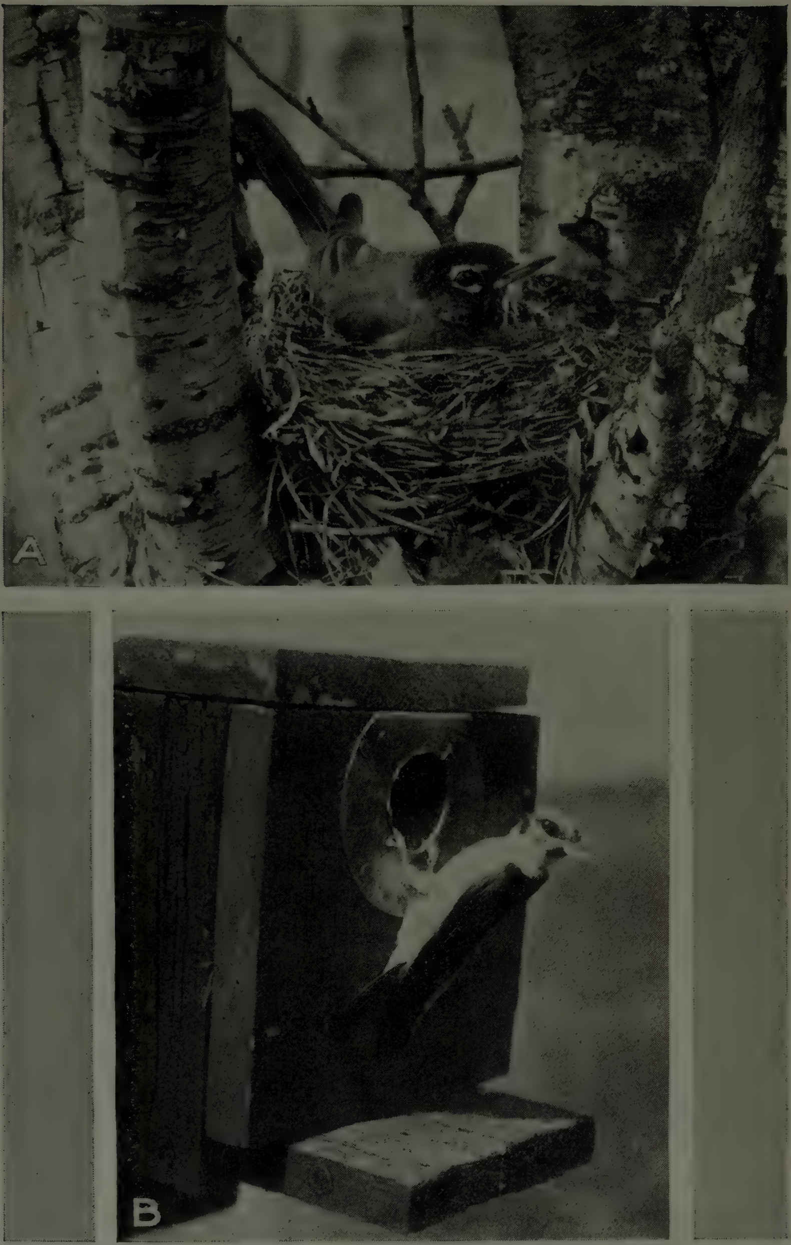


FIGURE 5.—Caring for the brood: A, Robin on nest—a bird universally known and almost everywhere beloved, sometimes too attentive to cultivated fruits (photograph by F. A. Kinsey); B, tree swallow at nest box, bringing a cranberry moth to its young (photograph by E. H. Forbush); swallows are tireless destroyers of a great variety of injurious insects

too fond of flowers, buds, and fruits, especially cherries, and while gratifying these tastes it consorts in such large flocks that the interests of mankind suffer considerably.

The butcher birds, or shrikes, which have the curious habit of hanging part of their prey upon thorns, in crotches, or in other suitable places, destroy some other birds, but on the whole are beneficial.

About 10 kinds of the smooth green-coated vireos and 55 kinds of warblers of varied and brilliant but neat plumages are special guardians of the foliage of trees. These little birds scan twig and branch and limb, snapping up the caterpillars, scale insects, plant lice, and others, which collectively are so great a drain upon the vitality of trees. There are millions of warblers and vireos in North America, and their destruction of insects in the aggregate is beyond conception.

Allied in service to the warblers are the bark-climbing creepers, the industrious and inquisitive nuthatches, the restless and active chickadees and titmice, and the tree-scanning kinglets and gnatcatchers, of which groups there are in the United States more than 25 species. They either pursue their prey chiefly among foliage, as do the warblers, or supplement this work by seeking insects on the bark of trees and in crevices and cavities everywhere. Some of the smaller of these birds are especially meritorious on account of their destruction of the eggs of insects.

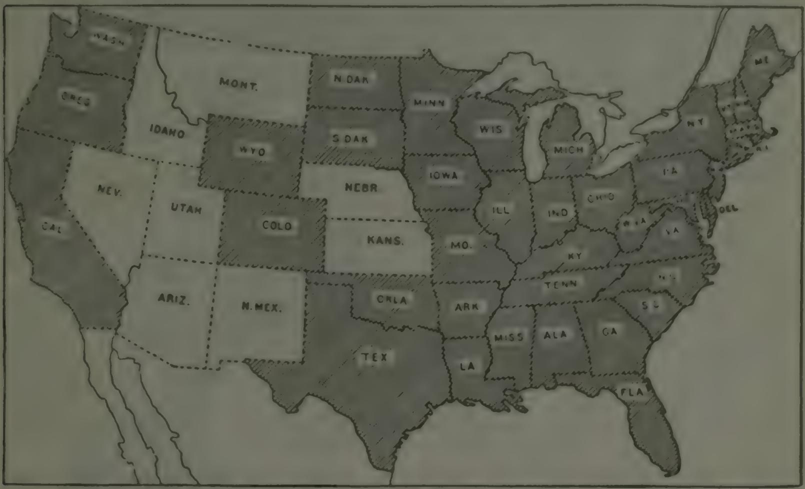


FIGURE 6.—The shaded area shows the States that have adopted the American Ornithologists' Union model law for the protection of birds

Mocking birds, catbirds, and thrashers are distinguished by unusual ability as songsters. Economically considered, all are rather too fond of cultivated fruits, but as a rule they do more good than harm, and experience shows that despite the damage they inflict these birds are usually desired in the vicinity of homes and even invited there for the sake of their songs.

Closely related to the mockers and thrashers are the wrens, 11 species of which occur in the United States. These little birds are incessantly active, tireless, and good singers, almost wholly insectivorous, and consequently beneficial to a high degree. About the only complaint made against them is that the familiar house wren interferes with the nests and eggs of other birds.

Only one family of small land birds remains to be mentioned, namely, that including the thrushes, robins, and bluebirds. The thrushes are characteristic woodland species, and while not of great economic importance are for the most part commendable in their

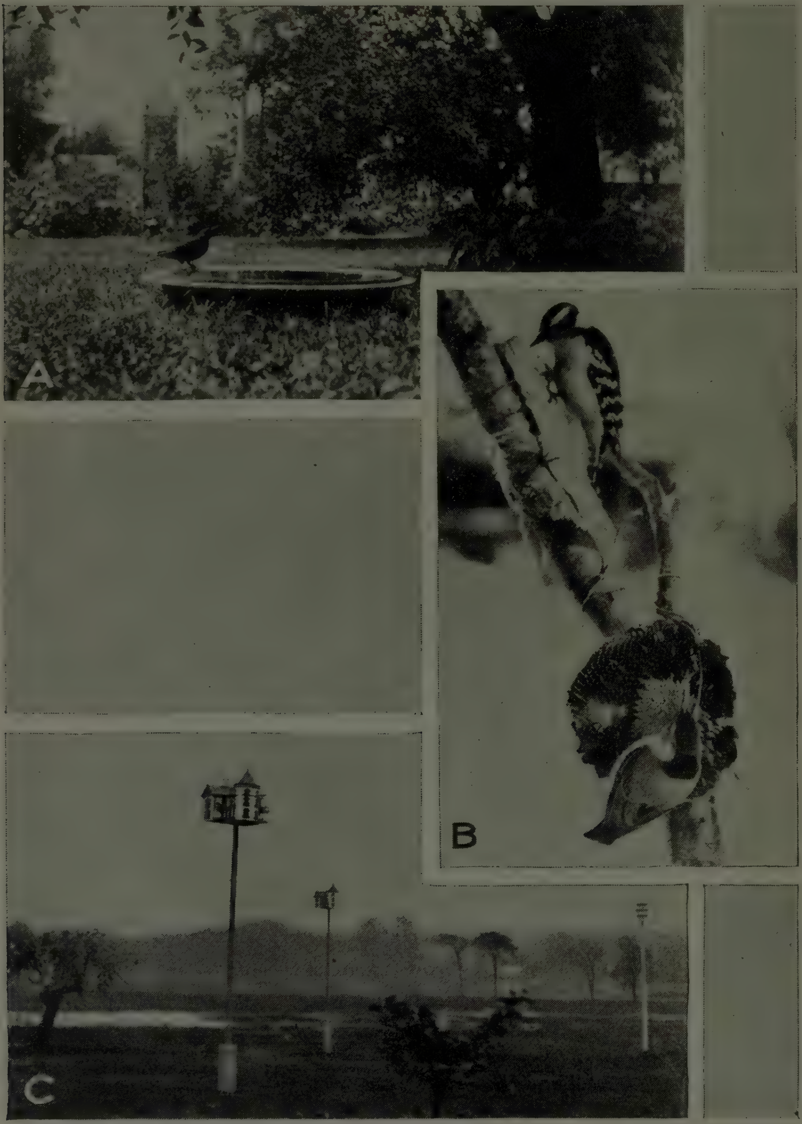


FIGURE 7.—Means of attracting birds: A, Bird bath or drinking fountain; B, food; and C, nesting sites, are the essentials for increasing the number of birds in a locality. Areas inhabited by large numbers of birds are ordinarily practically immune from the ravages of insects. (Photos A and B by F. E. Barker and Carl Purple, respectively; C, by E. H. Forbush)

relation to man. Robins and bluebirds are the most familiar species about our homes and so beloved are they that they are almost immune from persecution. The bluebirds strictly deserve this high consideration, but the robins (fig. 5, A) take a large toll from cultivated fruits, and probably are too numerous in many localities.

PUBLIC ATTITUDE TOWARD BIRDS

Public action in bird protection has received much attention in the United States. The Bureau of Biological Survey has proved the value of birds; the American Ornithologists' Union and the National Association of Audubon Societies have engaged in prolonged campaigning for bird protection. As a result, the American Ornithologists' Union model law for protection of birds has been adopted by 40 of the 48 States. (Fig. 6.) The migratory-bird treaty act, putting into force a treaty with Great Britain for the protection of migratory birds, supplements and reinforces the State legislation. So far as desirable laws are concerned, the United States leads the world in bird protection.

It remains for public opinion to back the law, for citizens to put into effect every practicable measure for increase and conservation of bird life. Experience has shown that efforts to attract birds and increase their numbers are rewarded by very encouraging results. The essentials of bird attraction (fig. 7) are the suppression of enemies and the provision of food, water, and nesting sites.

From the normal number of one pair of birds to the acre under natural conditions, bird-attraction methods[1] have increased the numbers in certain areas up to 10, 27, 40, and even more, pairs to an acre. Areas inhabited by such large bird populations ordinarily are practically immune from the destructiveness of insects.

Aside from the economic advantages of an increased number of birds, the esthetic phase of bird attraction must not be overlooked. Nearly everyone enjoys watching birds. Birds typify life, beauty, and sprightly activity, and the songs of many of them are sources of great pleasure. Their presence in large numbers means increase in all these forms of enjoyment.

Material increase in the number of birds admittedly is a two-sided problem: Some birds of little or no value should not be increased, while others, not now noticeably destructive, may become so when they are more abundant. On the other hand, there is no doubt that the majority of birds are more beneficial than injurious, and that by increasing their numbers we shall do ourselves and our country a valuable service.

---

[1] Publications giving details of methods of attracting birds may be obtained upon application to the U. S. Department of Agriculture. The following are suggested: Farmers' Bulletins 621, How to Attract Birds in the Northeastern States; 760, How to Attract Birds in the Northwestern States; 844, How to Attract Birds in the Middle Atlantic States; 912, How to Attract Birds in the East Central States; 1456, Homes for Birds; and 1644, Local Bird Refuges.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	ARTHUR M. HYDE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel and Business Administration.	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Solicitor	E. L. MARSHALL.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	R. Y. STUART, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Plant Quarantine and Control Administration	LEE A. STRONG, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*

U. S. GOVERNMENT PRINTING OFFICE: 1931

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

U. S. DEPARTMENT OF
AGRICULTURE
FARMERS' BULLETIN No. 1683

MEASURING WATER IN IRRIGATION CHANNELS

1862 1889

VARIOUS TYPES of weirs have long been employed for measuring the quantity of water flowing in irrigation channels. The Parshall measuring flume has only recently been developed.

The weirs in most common use are of the rectangular, Cipolletti, and 90° triangular-notch types. Weirs have the advantage of being easy to construct and operate. Their disadvantages are that they can not be installed in channels having slight fall, and the accumulation of silt above the weir notch may necessitate frequent cleaning and may render the device more or less inaccurate.

The Parshall measuring flume is more difficult to construct and install correctly, but it will measure water accurately in channels carrying silt or having comparatively slight fall.

This bulletin supersedes Farmers' Bulletin 813, Construction and Use of Farm Weirs.

Washington, D. C. **Issued January, 1932**

MEASURING WATER IN IRRIGATION CHANNELS[1]

By R. L. Parshall, *Senior Irrigation Engineer, Division of Irrigation, Bureau of Agricultural Engineering*

CONTENTS

Page
Introduction 1
Weirs 1
  Construction and setting 2
  Measurement 4
  Limitations of weirs 7
Parshall measuring flume 8
  Free flow 9
Parshall measuring flume—Continued.
  Submerged flow 11
  Setting and size 13
  Construction 14
  Stilling wells and gauges 15
Velocity of approach 16
Loss of head 17

INTRODUCTION

THE CHIEF OBJECT of accurately measuring irrigation water is its equitable distribution, both at the point of diversion and at other points, but when accurate measurement is employed it almost invariably results also in reducing waste, making possible the extension of the use of water to some to whom it previously had been denied because of its apparent scarcity. The purpose of this bulletin is to encourage and assist in the use of more accurate methods of measuring water flowing in open irrigation channels. It is not practicable to cover all methods which are employed, and this bulletin is therefore limited to descriptions of approved devices now in general use.

WEIRS

The weir is the simplest and most accurate of all of the more practical devices commonly used to measure water for irrigation purposes. In its simplest form it consists of a bulkhead having in its top an opening of fixed dimensions and shape for the passage of water. The opening is called the weir notch, its bottom edge the crest, and the depth of water passing over the crest the head. The horizontal distances from the ends of the crest to the sides of the weir box are called end contractions, and the vertical distance from the crest to the floor of the weir box or channel is the bottom contraction. When these distances are great enough to cause water to pond above the weir, so that it approaches the weir notch at a low velocity, the weir is said to have complete contractions. To create this condition the banks or sides of the channel upstream from the bulkhead must be distant from the end of the weir notch at least twice the maximum depth of water on the weir crest, the bottom of the channel must be lower than the weir crest by at least three times that maximum depth, and the velocity of approach must not exceed about 0.3 foot per second.

For proper operation of completely contracted weirs the channel upstream from the weir must be large enough to insure adequate stilling of the water. The stilling basin above the weir is called the weir box or weir pond. The sheet of water passing through the notch and falling over the weir is termed the "nappe." When the downstream water surface is far enough below the crest that air has free access under the nappe, the flow is said to be free; otherwise it is submerged.

---

[1] Prepared under the direction of W. W. McLaughlin, Chief, Division of Irrigation, Bureau of Agricultural Engineering, and in cooperation with the Colorado Agricultural Experiment Station.

Three weir types are considered in this bulletin: (1) The rectangular weir, of which the weir notch has a level crest and vertical sides; (2) the Cipolletti, or trapezoidal weir, with level crest but with the sides of the notch inclined outward from the vertical at slopes of 1 unit horizontally to 4 units vertically; (3) the 90° triangular-notch weir, formed by side slopes which are 45° from the vertical, meeting in a point.

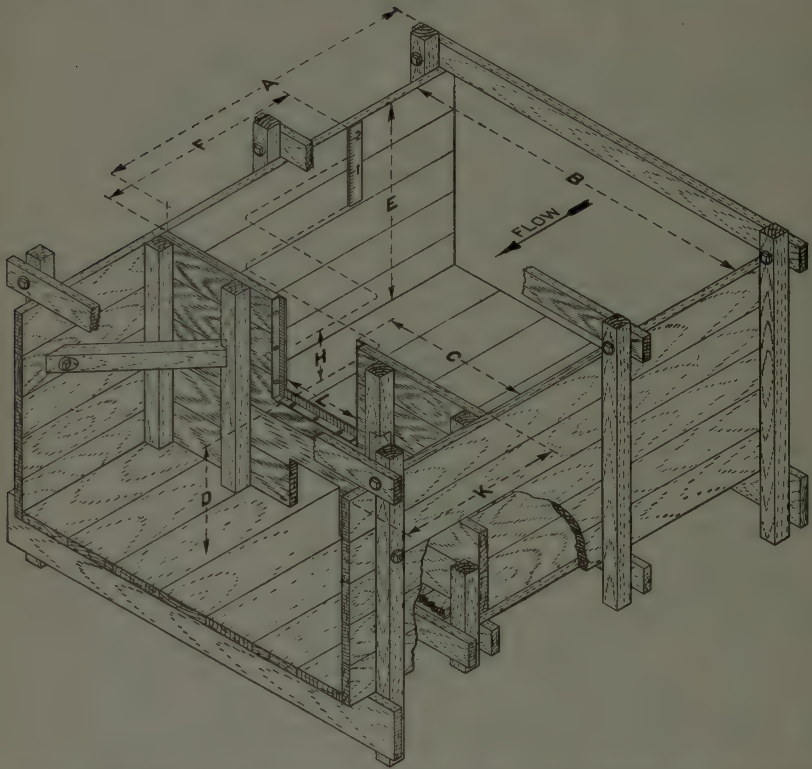


FIGURE 1.—Weir box with rectangular weir notch formed by angle-iron crest and sides

CONSTRUCTION AND SETTING

The crest and sides of a weir notch should be straight and their edges should not be more than one-eighth of an inch thick. The crest of a rectangular or Cipolletti weir should be level, and the sides should make exactly the proper angles with the crest. The sides of the triangular-notch weir should make 45° angles with a vertical line. A head of 0.1 foot over the crest is enough to permit the stream to clear the downstream edges of the crest and sides. For temporary use, a piece of stiff sheet metal cut in a semicircle approximately the shape of the cross section of the channel and somewhat larger with a weir notch cut in the top edge may serve for making rough measurements of small discharges. Such a device is called a portable weir. In setting this type of weir it is only necessary to force the metal plate firmly into the bottom and sides of the channel and then level the crest.

If a more permanent structure is desired, a wooden bulkhead properly supported by end posts and set well into the sides and bottom of the ditch may be built across the channel. The weir notch is cut into the top of this bulkhead. Experience has indicated that where the notch is made with crest and sides of wood, the edges may split, crack, or be crushed, causing irregularities and unsatisfactory measurements. It is better practice to cut a rectangular notch opening with a crest 3 inches longer than required, and use 1½ by 1½ by ⅛ inch angle iron for the finished crest and sides, as shown in Figure 1. The side pieces for such a rectangular weir should first be temporarily set and the crest piece firmly set between them. A carpenter's square and level may be used in finally determining the proper position of the vertical pieces. Heavy screws should be used to hold the pieces in place.

It is somewhat difficult to construct a weir of the Cipolletti type, using angle iron for the crest and sides of the notch, because of the angle made by the sides. For this reason it is perhaps better to cut the notch in a sheet of stiff metal and fasten the sheet to the inside face of the bulkhead, cutting the notch in the bulkhead 2 inches oversize in order not to interfere with the nappe. One objection to the Cipolletti type of weir, if only a bulkhead is constructed, is the difficulty of maintaining ample side and bottom contraction distances. To overcome this difficulty the bulkhead may be built inside a wood or concrete structure such as is shown in Figure 1. Dimensions of such a structure, for the rectangular, Cipolletti, or 90° triangular notch weir, are given in Table 1. The letters at the heads of the columns in Table 1 are intended to aid in identifying the various parts of the structure shown in Figure 1.

TABLE 1.—*Weir-box dimensions for rectangular, Cipolletti, and 90° triangular-notch weirs*

(The letters at the top of the box heads refer to Figure 1)

RECTANGULAR AND CIPOLLETTI WEIRS

Discharge	H Maximum head	L Length of weir crest	A Length of box above weir notch	K Length of box below weir notch	B Total width of box	E[1] Total depth of box	C End of crest to side of box	D Crest to bottom of box	F Gauge distance
Sec.-ft.	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
½ to 3	1.0	1	6	2	5½	3½	2¼	2	4
2 to 5	1.1	1½	7	3	7	4	2¾	2½	4½
4 to 8	1.2	2	8	4	8½	4½	3¼	2¾	5
6 to 14	1.3	3	9	5	12	5	4½	3¼	5½
10 to 22	1.5	4	10	6	14	5½	5	3½	6

90° TRIANGULAR-NOTCH WEIR

Discharge	H	L	A	K	B	E[1]	C	D	F
½ to 2¼	1.00	....	6	2	5	3	2½	1½	4
2 to 4⅓	1.25	....	6½	8½	6½	3¼	3¼	1½	5

[1] This distance allows for about 6 inches freeboard above highest water level in weir box.

The weir box should be set in a straight section of the channel, with the floor level in both directions and the side walls vertical. To prevent undermining or washing around the structure, cut-off walls should be provided at both ends and the back filling tamped in place. If the bulkhead is set upstream from the lower end of the structure, a portion of the floor downstream from the bulkhead will serve to prevent erosion of the bottom of the channel. The banks and bottom of the channel for 15 to 20 feet upstream from the weir box should be trimmed to conform approximately to the cross section of the box.

One of the main difficulties in the use of weirs is the accumulation of deposits in the weir box. Hand cleaning by means of a shovel or by team and scraper where convenient, is frequently necessary to maintain proper contraction distances. For cleaning the weir box, an opening of sufficient size through which the deposits may be sluiced out and passed on down the channel, may be provided in the bulkhead at the floor line beneath the weir notch. (Fig. 1.) A removable gate or cover should be provided for this opening and securely fixed in place when the weir is in operation.

MEASUREMENT

The discharge in cubic feet per second over the weir crest is determined directly by the depth or head (H) in feet, and the length of crest (L) in feet. As the water passes through the weir notch, its surface curves downward. This curved surface, or drawdown extends upstream a short distance from the weir notch. The head should be determined at a point in the quiet water above this drawdown. For general practice, the distance upstream from the bulkhead to the gauge point should be not less than four times the maximum head to be run over the crest, or the head may be taken at the wall of the weir box at either end of the bulkhead. A staff gauge, having a graduated scale on which the zero is at the same elevation as the weir crest, is usually fixed to the inside face of the weir box in a vertical position at the gauge point. For more accurate readings of the head a stilling well such as is shown in Figure 7 may be used.

Where a simple bulkhead is placed across the channel, a stake or post may be driven into the bed of the weir pond, until its top is level with the crest of the weir. The depth of the water over this post will be the head on the crest. This post should be far enough back to be outside of the effect of the drawdown, and where it can be easily reached from the bank of the channel.

To determine the rate of discharge over the weir, observe the depth of water on the weir crest in feet or inches and refer to Table 2, 3, or 4, depending on the type of weir. These tables are applicable only to weirs installed in the manner previously described.

TABLE 2.—*Discharge table for rectangular weirs with complete contractions computed from the formula* $Q=3.247LH^{1.48}-\left(\frac{0.566L^{1.8}}{1+2L^{1.8}}\right)H^{1.9}$

Head, H [1]		Discharge, Q, for crest lengths, L, of—					Head, H		Discharge, Q, for crest lengths, L, of—				
		1 foot	1.5 feet	2 feet	3 feet	4 feet			1 foot	1.5 feet	2 feet	3 feet	4 feet
Feet	*Inches*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Feet*	*Inches*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
0.10	1 3/16	0.11	0.16	0.22	0.33	0.44	0.75	9	2.01	3.05	4.09	6.21	8.33
.11	1 5/16	.12	.18	.25	.37	.50	.76	9 1/8	2.05	3.11	4.18	6.33	8.49
.12	1 7/16	.14	.20	.28	.42	.57	.77	9 1/4	2.09	3.17	4.26	6.45	8.66
.13	1 9/16	.15	.22	.32	.47	.64	.78	9 3/8	2.13	3.23	4.34	6.58	8.82
.14	1 11/16	.17	.25	.35	.53	.71	.79	9 1/2	2.17	3.29	4.42	6.70	8.99
.15	1 13/16	.19	.28	.39	.58	.79	.80	9 5/8	2.21	3.35	4.51	6.83	9.16
.16	1 15/16	.21	.31	.43	.64	.86	.81	9 3/4	2.25	3.41	4.59	6.95	9.33
.17	2 1/16	.23	.34	.47	.70	.95	.82	9 13/16	2.29	3.47	4.67	7.08	9.50
.18	2 3/16	.25	.37	.51	.76	1.03	.83	9 15/16	2.33	3.54	4.75	7.21	9.67
.19	2 1/4	.27	.40	.55	.83	1.11	.84	10 1/16	2.37	3.60	4.84	7.33	9.84
.20	2 3/8	.29	.44	.59	.89	1.19	.85	10 3/16	2.41	3.66	4.92	7.46	10.0
.21	2 1/2	.31	.47	.63	.95	1.28	.86	10 5/16	2.46	3.72	5.01	7.59	10.2
.22	2 5/8	.34	.50	.68	1.02	1.37	.87	10 7/16	2.50	3.79	5.10	7.72	10.4
.23	2 3/4	.36	.54	.72	1.09	1.46	.88	10 9/16	2.54	3.85	5.18	7.85	10.5
.24	2 7/8	.38	.57	.77	1.16	1.55	.89	10 11/16	2.58	3.92	5.27	7.99	10.7
.25	3	.40	.61	.82	1.23	1.65	.90	10 13/16	2.62	3.98	5.35	8.12	10.9
.26	3 1/8	.43	.65	.86	1.31	1.75	.91	10 15/16	2.67	4.05	5.44	8.25	11.1
.27	3 1/4	.45	.68	.91	1.38	1.85	.92	11 1/16	2.71	4.11	5.53	8.38	11.2
.28	3 3/8	.48	.72	.96	1.46	1.95	.93	11 3/16	2.75	4.18	5.62	8.52	11.4
.29	3 1/2	.50	.76	1.02	1.53	2.05	.94	11 1/4	2.79	4.24	5.71	8.65	11.6
.30	3 5/8	.53	.80	1.07	1.61	2.16	.95	11 3/8	2.84	4.31	5.80	8.79	11.8
.31	3 3/4	.55	.84	1.12	1.69	2.26	.96	11 1/2	2.88	4.37	5.89	8.93	12.0
.32	3 13/16	.58	.88	1.18	1.77	2.37	.97	11 5/8	2.93	4.44	5.98	9.06	12.2
.33	3 15/16	.61	.92	1.23	1.86	2.48	.98	11 3/4	2.97	4.51	6.07	9.20	12.3
.34	4 1/16	.63	.96	1.28	1.94	2.60	.99	11 7/8	3.01	4.57	6.16	9.34	12.5
.35	4 3/16	.66	1.00	1.34	2.02	2.71	1.00	12	3.06	4.64	6.25	9.48	12.7
.36	4 5/16	.69	1.04	1.40	2.11	2.82	1.01	12 1/8	......	4.71	6.34	9.62	12.9
.37	4 7/16	.72	1.08	1.45	2.20	2.94	1.02	12 1/4	......	4.78	6.43	9.76	13.1
.38	4 9/16	.74	1.13	1.51	2.28	3.06	1.03	12 3/8	......	4.85	6.52	9.90	13.3
.39	4 11/16	.77	1.17	1.57	2.37	3.18	1.04	12 1/2	......	4.92	6.62	10.0	13.5
.40	4 13/16	.80	1.21	1.63	2.46	3.30	1.05	12 5/8	......	4.98	6.71	10.2	13.7
.41	4 15/16	.83	1.26	1.69	2.55	3.42	1.06	12 3/4	......	5.05	6.80	10.3	13.8
.42	5 1/16	.86	1.30	1.75	2.65	3.54	1.07	12 13/16	......	5.12	6.90	10.5	14.0
.43	5 3/16	.89	1.35	1.81	2.74	3.67	1.08	12 15/16	......	5.20	6.99	10.6	14.2
.44	5 1/4	.92	1.40	1.88	2.83	3.80	1.09	13 1/16	......	5.26	7.09	10.8	14.4
.45	5 3/8	.96	1.44	1.94	2.93	3.93	1.10	13 3/16	......	5.34	7.19	10.9	14.6
.46	5 1/2	.99	1.49	2.00	3.03	4.05	1.11	13 5/16	......	5.41	7.28	11.0	14.8
.47	5 5/8	1.02	1.54	2.07	3.12	4.18	1.12	13 7/16	......	5.48	7.38	11.2	15.0
.48	5 3/4	1.05	1.59	2.13	3.22	4.32	1.13	13 9/16	......	5.55	7.47	11.3	15.2
.49	5 7/8	1.08	1.64	2.20	3.32	4.45	1.14	13 11/16	......	5.62	7.57	11.5	15.4
.50	6	1.11	1.68	2.26	3.42	4.58	1.15	13 13/16	......	5.69	7.66	11.6	15.6
.51	6 1/8	1.15	1.73	2.33	3.52	4.72	1.16	13 15/16	......	5.77	7.76	11.8	15.8
.52	6 1/4	1.18	1.78	2.40	3.62	4.86	1.17	14 1/16	......	5.84	7.86	11.9	16.0
.53	6 3/8	1.21	1.84	2.46	3.73	4.99	1.18	14 3/16	......	5.91	7.96	12.1	16.2
.54	6 1/2	1.25	1.89	2.53	3.83	5.13	1.19	14 1/4	......	5.98	8.06	12.2	16.4
.55	6 5/8	1.28	1.94	2.60	3.94	5.27	1.20	14 3/8	......	6.06	8.16	12.4	16.6
.56	6 3/4	1.31	1.99	2.67	4.04	5.42	1.21	14 1/2	......	6.13	8.26	12.5	16.8
.57	6 13/16	1.35	2.04	2.74	4.15	5.56	1.22	14 5/8	......	6.20	8.35	12.7	17.0
.58	6 15/16	1.38	2.09	2.81	4.26	5.70	1.23	14 3/4	......	6.28	8.46	12.8	17.2
.59	7 1/16	1.42	2.15	2.88	4.36	5.85	1.24	14 7/8	......	6.35	8.56	13.0	17.4
.60	7 3/16	1.45	2.20	2.96	4.47	6.00	1.25	15	......	6.43	8.66	13.1	17.6
.61	7 5/16	1.49	2.25	3.03	4.58	6.14	1.26	15 1/8	......	......	......	13.3	17.9
.62	7 7/16	1.52	2.31	3.10	4.69	6.29	1.27	15 1/4	......	......	......	13.4	18.1
.63	7 9/16	1.56	2.36	3.17	4.81	6.44	1.28	15 3/8	......	......	......	13.6	18.3
.64	7 11/16	1.60	2.42	3.25	4.92	6.59	1.29	15 1/2	......	......	......	13.8	18.5
.65	7 13/16	1.63	2.47	3.32	5.03	6.75	1.30	15 5/8	......	......	......	13.9	18.7
.66	7 15/16	1.67	2.53	3.40	5.15	6.90	1.31	15 3/4	......	......	......	14.1	18.9
.67	8 1/16	1.71	2.59	3.47	5.26	7.05	1.32	15 13/16	......	......	......	14.2	19.1
.68	8 3/16	1.74	2.64	3.55	5.38	7.21	1.33	15 15/16	......	......	......	14.4	19.3
.69	8 1/4	1.78	2.70	3.63	5.49	7.36	1.34	16 1/16	......	......	......	14.6	19.6
.70	8 3/8	1.82	2.76	3.71	5.61	7.52	1.35	16 3/16	......	......	......	14.7	19.8
.71	8 1/2	1.86	2.81	3.78	5.73	7.68	1.36	16 5/16	......	......	......	14.9	20.0
.72	8 5/8	1.90	2.87	3.86	5.85	7.84	1.37	16 7/16	......	......	......	15.0	20.2
.73	8 3/4	1.93	2.93	3.94	5.97	8.00	1.38	16 9/16	......	......	......	15.2	20.4
.74	8 7/8	1.97	2.99	4.02	6.09	8.17	1.39	16 11/16	......	......	......	15.4	20.6

---

[1] Values of discharge for heads up to 0.20 foot do not follow the formula but are taken directly from the calibration curve.

TABLE 3.—*Discharge table for Cipolletti weirs with complete contractions computed from the formula* $Q=3.247LH^{1.48}-\left(\frac{0.566L^{1.8}}{1+2L^{1.8}}\right)H^{1.9}+0.609H^{2.5}$

Head, H[1]		Discharge, Q, for crest lengths, L, of—					Head, H		Discharge, Q, for crest lengths, L, of—				
		1 foot	1.5 feet	2 feet	3 feet	4 feet			1 foot	1.5 feet	2 feet	3 feet	4 feet
Feet	*Inches*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Feet*	*Inches*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
0.10	1 3/16	0.11	0.16	0.23	0.33	0.44	0.75	9	2.31	3.35	4.40	6.51	8.62
.11	1 5/16	.12	.18	.26	.38	.50	.76	9⅛	2.36	3.42	4.49	6.64	8.80
.12	1 7/16	.14	.21	.29	.43	.57	.77	9¼	2.41	3.49	4.58	6.77	8.97
.13	1 9/16	.16	.24	.32	.48	.64	.78	9⅜	2.46	3.56	4.67	6.90	9.15
.14	1 11/16	.17	.26	.36	.54	.71	.79	9½	2.51	3.63	4.76	7.04	9.33
.15	1 13/16	.19	.29	.39	.59	.79	.80	9⅝	2.56	3.70	4.85	7.18	9.51
.15	1 15/16	.21	.32	.43	.65	.87	.81	9¾	2.61	3.77	4.95	7.31	9.69
.17	2 1/16	.23	.36	.47	.71	.96	.82	9 13/16	2.66	3.84	5.04	7.45	9.87
.18	2 3/16	.25	.39	.51	.77	1.04	.83	9 15/16	2.71	3.92	5.14	7.59	10.0
.19	2¼	.28	.42	.56	.83	1.12	.84	10 1/16	2.77	3.99	5.23	7.73	10.2
.20	2⅜	.30	.45	.60	.90	1.20	.85	10 3/16	2.82	4.07	5.33	7.87	10.4
.21	2½	.32	.48	.64	.97	1.29	.86	10 5/16	2.87	4.14	5.43	8.01	10.6
.22	2⅝	.35	.52	.69	1.04	1.38	.87	10 7/16	2.93	4.22	5.52	8.15	10.8
.23	2¾	.37	.55	.74	1.11	1.47	.88	10 9/16	2.98	4.29	5.62	8.30	11.0
.24	2⅞	.39	.59	.79	1.18	1.57	.89	10 11/16	3.04	4.37	5.72	8.44	11.2
.25	3	.42	.63	.84	1.25	1.67	.90	10 13/16	3.09	4.45	5.82	8.59	11.4
.26	3⅛	.45	.67	.89	1.33	1.77	.91	10 15/16	3.15	4.53	5.92	8.73	11.6
.27	3¼	.47	.70	.94	1.40	1.87	.92	11 1/16	3.20	4.60	6.02	8.88	11.7
.28	3⅜	.50	.74	.99	1.48	1.97	.93	11 3/16	3.26	4.68	6.13	9.03	11.9
.29	3½	.53	.79	1.04	1.56	2.08	.94	11¼	3.32	4.76	6.23	9.17	12.1
.30	3⅝	.56	.83	1.10	1.64	2.19	.95	11⅜	3.37	4.84	6.33	9.32	12.3
.31	3¾	.59	.87	1.15	1.73	2.30	.96	11½	3.43	4.92	6.44	9.48	12.5
.32	3 13/16	.61	.91	1.21	1.80	2.41	.97	11⅝	3.49	5.00	6.55	9.62	12.7
.33	3 15/16	.64	.95	1.27	1.89	2.52	.98	11¾	3.55	5.09	6.64	9.78	12.9
.34	4 1/16	.67	1.00	1.32	1.98	2.64	.99	11⅞	3.61	5.17	6.75	9.93	13.1
.35	4 3/16	.70	1.04	1.38	2.07	2.75	1.00	12	3.67	5.25	6.86	10.1	13.3
.36	4 5/16	.73	1.09	1.44	2.16	2.87	1.01	12⅛	-------	5.33	6.96	10.2	13.5
.37	4 7/16	.77	1.13	1.50	2.25	2.99	1.02	12¼	-------	5.42	7.07	10.4	13.7
.38	4 9/16	.80	1.18	1.57	2.34	3.11	1.03	12⅜	-------	5.50	7.18	10.6	13.9
.39	4 11/16	.83	1.23	1.63	2.43	3.24	1.04	12½	-------	5.59	7.29	10.7	14.2
.40	4 13/16	.87	1.28	1.69	2.53	3.36	1.05	12⅝	-------	5.67	7.40	10.9	14.4
.41	4 15/16	.90	1.32	1.76	2.62	3.49	1.06	12¾	-------	5.76	7.51	11.0	14.6
.42	5 1/16	.93	1.37	1.82	2.72	3.61	1.07	12 13/16	-------	5.84	7.62	11.2	14.8
.43	5 3/16	.97	1.42	1.89	2.81	3.74	1.08	12 15/16	-------	5.93	7.73	11.4	15.0
.44	5¼	1.00	1.47	1.95	2.91	3.87	1.09	13 1/16	-------	6.02	7.84	11.5	15.2
.45	5⅜	1.04	1.53	2.02	3.01	4.01	1.10	13 3/16	-------	6.11	7.96	11.7	15.4
.46	5½	1.07	1.58	2.09	3.11	4.14	1.11	13 5/16	-------	6.20	8.07	11.8	15.6
.47	5⅝	1.11	1.63	2.16	3.21	4.28	1.12	13 7/16	-------	6.29	8.18	12.0	15.8
.48	5¾	1.15	1.68	2.23	3.32	4.41	1.13	13 9/16	-------	6.37	8.29	12.2	16.0
.49	5⅞	1.18	1.74	2.30	3.42	4.55	1.14	13 11/16	-------	6.46	8.41	12.3	16.3
.50	6	1.22	1.79	2.37	3.53	4.69	1.15	13 13/16	-------	6.56	8.53	12.5	16.5
.51	6⅛	1.26	1.85	2.44	3.64	4.83	1.16	13 15/16	-------	6.65	8.65	12.7	16.7
.52	6¼	1.30	1.90	2.51	3.74	4.97	1.17	14 1/16	-------	6.74	8.76	12.8	16.9
.53	6⅜	1.34	1.96	2.59	3.85	5.12	1.18	14 3/16	-------	6.83	8.88	13.0	17.2
.54	6½	1.38	2.02	2.66	3.96	5.26	1.19	14¼	-------	6.93	9.00	13.2	17.4
.55	6⅝	1.42	2.07	2.74	4.07	5.41	1.20	14⅜	-------	7.02	9.12	13.4	17.6
.56	6¾	1.46	2.13	2.81	4.18	5.56	1.21	14½	-------	7.11	9.24	13.5	17.8
.57	6 13/16	1.50	2.19	2.89	4.30	5.71	1.22	14⅝	-------	7.20	9.36	13.7	18.0
.58	6 15/16	1.54	2.25	2.97	4.41	5.86	1.23	14¾	-------	7.30	9.48	13.9	18.3
.59	7 1/16	1.58	2.31	3.05	4.53	6.01	1.24	14⅞	-------	7.40	9.60	14.0	18.5
.60	7 3/16	1.62	2.37	3.13	4.64	6.17	1.25	15	-------	7.49	9.72	14.2	18.7
.61	7 5/16	1.67	2.43	3.20	4.76	6.32	1.26	15⅛	-------	-------	-------	14.4	19.0
.62	7 7/16	1.71	2.49	3.28	4.88	6.47	1.27	15¼	-------	-------	-------	14.6	19.2
.63	7 9/16	1.75	2.55	3.37	5.00	6.63	1.28	15⅜	-------	-------	-------	14.7	19.4
.64	7 11/16	1.80	2.62	3.45	5.12	6.79	1.29	15½	-------	-------	-------	14.9	19.6
.65	7 13/16	1.84	2.68	3.53	5.24	6.95	1.30	15⅝	-------	-------	-------	15.1	19.9
.66	7 15/16	1.89	2.75	3.61	5.36	7.11	1.31	15¾	-------	-------	-------	15.3	20.1
.67	8 1/16	1.93	2.81	3.70	5.48	7.28	1.32	15 13/16	-------	-------	-------	15.5	20.3
.68	8 3/16	1.98	2.87	3.79	5.61	7.44	1.33	15 15/16	-------	-------	-------	15.6	20.6
.69	8¼	2.02	2.94	3.87	5.73	7.61	1.34	16 1/16	-------	-------	-------	15.8	20.8
.70	8⅜	2.07	3.01	3.95	5.86	7.77	1.35	16 3/16	-------	-------	-------	16.0	21.1
.71	8½	2.12	3.07	4.04	5.99	7.94	1.36	16 5/16	-------	-------	-------	16.2	21.3
.72	8⅝	2.16	3.14	4.13	6.12	8.11	1.37	16 7/16	-------	-------	-------	16.4	21.5
.73	8¾	2.21	3.21	4.22	6.24	8.28	1.38	16 9/16	-------	-------	-------	16.6	21.8
.74	8⅞	2.26	3.28	4.31	6.38	8.45	1.39	16 11/16	-------	-------	-------	16.8	22.0

---

[1] Values of discharge for heads up to 0.20 foot do not follow the formula but are taken directly from the calibration curve.

TABLE 4.—*Discharge table for 90° triangular-notch weir with complete contractions computed from the formula* $Q = 2.49H^{2.48}$

Head, H		Discharge, Q	Head, H		Discharge, Q	Head, H		Discharge, Q
Feet	*Inches*	*Sec.-ft.*	*Feet*	*Inches*	*Sec.-ft.*	*Feet*	*Inches*	*Sec.-ft.*
0.20	2 3/8	0.046	0.55	6 5/8	0.564	0.90	10 13/16	1.92
.21	2 1/2	.052	.56	6 3/4	.590	.91	10 15/16	1.97
.22	2 5/8	.058	.57	6 13/16	.617	.92	11 1/16	2.02
.23	2 3/4	.065	.58	6 15/16	.644	.93	11 3/16	2.08
.24	2 7/8	.072	.59	7 1/16	.672	.94	11 1/4	2.13
.25	3	.080	.60	7 3/16	.700	.95	11 3/8	2.19
.26	3 1/8	.088	.61	7 5/16	.730	.96	11 1/2	2.25
.27	3 1/4	.096	.62	7 7/16	.760	.97	11 5/8	2.31
.28	3 3/8	.106	.63	7 9/16	.790	.98	11 3/4	2.37
.29	3 1/2	.115	.64	7 11/16	.822	.99	11 7/8	2.43
.30	3 5/8	.125	.65	7 13/16	.854	1.00	12	2.49
.31	3 3/4	.136	.66	7 15/16	.887	1.01	12 1/8	2.55
.32	3 13/16	.147	.67	8 1/16	.921	1.02	12 1/4	2.61
.33	3 15/16	.159	.68	8 3/16	.955	1.03	12 3/8	2.68
.34	4 1/16	.171	.69	8 1/4	.991	1.04	12 1/2	2.74
.35	4 3/16	.184	.70	8 3/8	1.03	1.05	12 5/8	2.81
.36	4 5/16	.197	.71	8 1/2	1.06	1.06	12 3/4	2.87
.37	4 7/16	.211	.72	8 5/8	1.10	1.07	12 13/16	2.94
.38	4 9/16	.225	.73	8 3/4	1.14	1.08	12 15/16	3.01
.39	4 11/16	.240	.74	8 7/8	1.18	1.09	13 1/16	3.08
.40	4 13/16	.256	.75	9	1.22	1.10	13 3/16	3.15
.41	4 15/16	.272	.76	9 1/8	1.26	1.11	13 5/16	3.22
.42	5 1/16	.289	.77	9 1/4	1.30	1.12	13 7/16	3.30
.43	5 3/16	.306	.78	9 3/8	1.34	1.13	13 9/16	3.37
.44	5 1/4	.324	.79	9 1/2	1.39	1.14	13 11/16	3.44
.45	5 3/8	.343	.80	9 5/8	1.43	1.15	13 13/16	3.52
.46	5 1/2	.362	.81	9 3/4	1.48	1.16	13 15/16	3.59
.47	5 5/8	.382	.82	9 13/16	1.52	1.17	14 1/16	3.67
.48	5 3/4	.403	.83	9 15/16	1.57	1.18	14 3/16	3.75
.49	5 7/8	.424	.84	10 1/16	1.61	1.19	14 1/4	3.83
.50	6	.445	.85	10 3/16	1.66	1.20	14 3/8	3.91
.51	6 1/8	.468	.86	10 5/16	1.71	1.21	14 1/2	3.99
.52	6 1/4	.491	.87	10 7/16	1.76	1.22	14 5/8	4.07
.53	6 3/8	.515	.88	10 9/16	1.81	1.23	14 3/4	4.16
.54	6 1/2	.539	.89	10 11/16	1.86	1.24	14 7/8	4.24
						1.25	15	4.33

LIMITATIONS OF WEIRS

The weir, when properly set and maintained, is perhaps the most accurate means of measuring flowing water, but when operated under field conditions, such as are found in irrigation practice, it is often unreliable. In order that a weir shall continue to measure water accurately the side and bottom contraction distances must remain unchanged. Water passing through earth channels carries more or less sand and sediment which accumulate in the weir box or pond, upstream from the weir bulkhead. This filling eventually destroys the standard bottom-contraction distance, thus increasing the velocity of the water's approach. The error thus caused in the rate of discharge is slight at first, but when the surface of the deposit approaches the level of the crest, the increase in discharge over that indicated by the head is appreciable.

Wooden crest and sides for a weir notch are not desirable, as their natural wear and deterioration dull the edge of the notch and result in increased discharge. A weir box built to provide proper side and bottom contraction distances requires a large amount of material.

In many cases the weir can not be used because of insufficient grade or available head. If the surface of the water below the weir rises above the crest level, the rate of flow is reduced. Moreover, a weir may easily be altered in order to obtain an unfair advantage either way.

PARSHALL MEASURING FLUME

The Parshall measuring flume consists of a converging section, a throat, and a diverging section, the floor of the throat section being inclined as shown in Figure 2, section L–L. Numerous field experiments have proved this device to be accurate and dependable.

The discharge through the Parshall flume is called free flow when the elevation of the water surface downstream from the throat of the flume is not sufficient to cause the flow to be retarded by the backwater. When the surface downstream is high enough to affect the flow, the critical point of submergence has been reached and the condition of submerged flow begins. At first the discharge is only slightly decreased, but as the degree of submergence increases a greater reduction in the rate of flow results; when the downstream and upstream water surfaces have the same elevation the submergence is said to be complete.

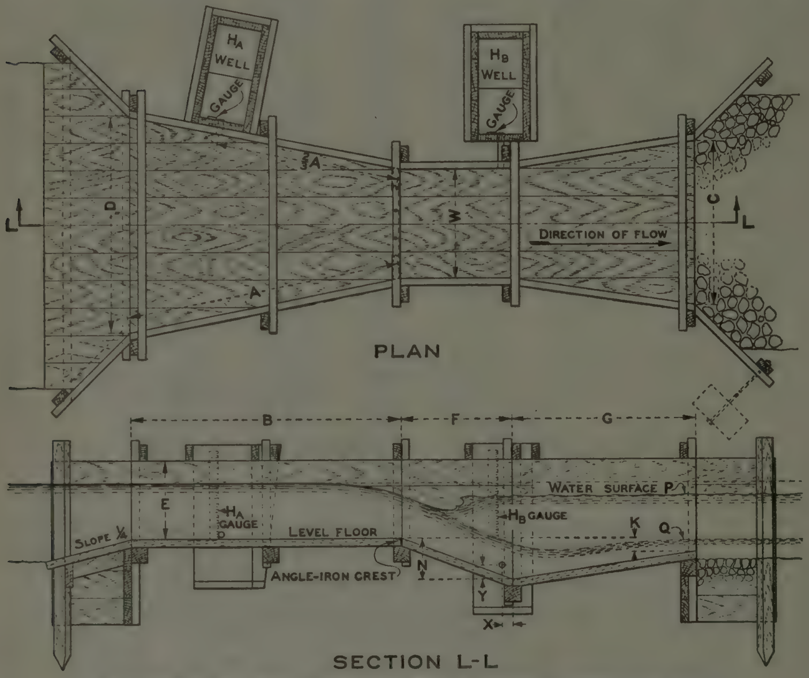


FIGURE 2.—Plan and elevation of the Parshall measuring flume

Two advantages of the Parshall measuring flume are that its accuracy is not affected by a high degree of submergence and the high velocity of the water in the converging section prevents accumulation of sand and silt.

Table 5 gives the required dimensions for various sizes of the Parshall measuring flume, the letters referring to Figure 2. The size of flume (W) is taken as the horizontal distance between the vertical, parallel walls of the throat section, and is identical with the crest, which is the line where the level floor of the converging section joins the inclined floor of the throat section. The floor of the converging section is level both transversely and longitudinally. For flumes ranging in size from 1 foot to 4 feet, the lengths of the throat and diverging sections are uniformly 2 feet and 3 feet, respectively. The floor of the throat section slopes downward from the crest 9 inches in 2 feet of length. The floor of the diverging section in the 1-foot to 4-foot sizes slopes upward 6 inches in 3 feet; thus the elevation of the floor of the downstream end of the flume is 3 inches lower than the crest. The length of the side wall of the converging section (fig. 2, A) has been arbitrarily taken as $\frac{W}{2}+4$, which determines the axial length (B) as given in Table 5 for the 1 to 4 foot flumes. The smaller flumes, 0.25, 0.50, and 0.75 foot, depart somewhat from the ratios of dimensions applicable to the larger flumes.

TABLE 5.—*Dimensions and capacities of the Parshall measuring flume, for various crest lengths*

(Letters refer to Figure 2)

W	A	$\frac{2}{3}$ A	B	C	D	E	F	G	K	N	X	Y	Free-flow capacity	
													Maximum	Minimum
Feet	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft. in.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*In.*	*Sec. ft.*	*Sec. ft.*
0.25	1 6⅜	1 ¼	1 6	7	10³⁄₁₆	1 3	½	1	1	2¼	1	1½	1.2	0.03
.50	2 ⁷⁄₁₆	1 4⁵⁄₁₆	2	1 3½	1 3½	1 6	1	2	3	4½	2	3	2.9	.05
.75	2 10⅝	1 11⅛	2 10	1 3	1 10⅝	2	1	1½	3	4½	2	3	5.7	.1
1	4 6	3	4 4⅞	2	2 9¼	3	2	3	3	9	2	3	16	.4
2	5	3 4	4 10⅞	3	3 11½	3	2	3	3	9	2	3	33	.7
3	5 6	3 8	5 4¾	4	5 1⅞	3	2	3	3	9	2	3	50	1.0
4	6	4	5 10⅝	5	6 4¼	3	2	3	3	9	2	3	68	1.3

The rate of flow is determined by the head or depth of water at H_A (fig. 2) in case a free-flow condition exists, and at both H_A and H_B in the case of submerged flow. The upper head (H_A) is observed at a point whose distance from the end of the crest is two-thirds of the length of the side wall of the converging section. (Fig. 2, $\frac{2}{3}$ A.) The lower head (H_B) is observed near the downstream end of the throat section. Both gauges H_A and H_B should be set with the zeros of the scales at the elevation of the crest of the flume.

FREE FLOW

Free flow is that condition under which the rate of discharge is dependent solely upon the length of the crest and the depth at the gauge point, H_A, in the converging section. Because of the ability of the Parshall measuring flume to withstand a relatively high degree of submergence without reduction in the rate of flow, free-flow discharge is obtained with a rather wide range of backwater conditions downstream from the structure. It has been observed that the stream passing through the throat can assume two different stages of free flow: (1) The water at high velocity moves in a thin sheet which conforms closely with the dip at the lower end of the throat (indicated by Q in Figure 2), and (2) the backwater raises the water surface to P, causing a ripple or wave to form at or near the downstream end of the throat. For this higher stage (P) there occurs a marked reduction in the velocity of the water as it leaves the lower end of the flume. If the ratio of the H_B gauge to the H_A gauge is 0.7 or less for the 1 to 4 foot flumes, or 0.6 for the 0.25, 0.50, and 0.75 foot flumes, then the rate of discharge may be found by measuring the depth at the H_A gauge and referring to Table 6. The ratio of the H_B gauge to the H_A gauge is found by dividing the depth or head at H_B by the depth as measured at H_A.

Table 6 gives the rates of discharge in second-feet through this flume for sizes of from 0.25 foot to 4 feet. The 0.25-foot flume is intended for the accurate measurements of small flows down to approximate one-thirtieth second-foot as a minimum.

TABLE 6.—*Free flow discharge through Parshall measuring flume*[1]

Head, H_A	Discharge, Q, for throat widths, W, of—						
	0.25 foot	0.50 foot	0.75 foot	1 foot	2 feet	3 feet	4 feet
Feet	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
0.10	0.028	0.05	0.09	------	------	------	------
.11	.033	.06	.10	------	------	------	------
.12	.037	.07	.12	------	------	------	------
.13	.042	.08	.14	------	------	------	------
.14	.047	.09	.15	------	------	------	------
.15	.053	.10	.17	------	------	------	------
.16	.058	.11	.19	------	------	------	------
.17	.064	.12	.20	------	------	------	------
.18	.070	.14	.22	------	------	------	------
.19	.076	.15	.24	------	------	------	------
.20	.082	.16	.26	0.35	0.66	0.97	1.26
.21	.089	.18	.28	.37	.71	1.04	1.36
.22	.095	.19	.30	.40	.77	1.12	1.47
.23	.102	.20	.32	.43	.82	1.20	1.58
.24	.109	.22	.35	.46	.88	1.28	1.68
.25	.117	.23	.37	.49	.93	1.37	1.80
.26	.124	.25	.39	.51	.99	1.46	1.91
.27	.131	.26	.41	.54	1.05	1.55	2.03
.28	.138	.28	.44	.58	1.11	1.64	2.15
.29	.146	.29	.46	.61	1.18	1.73	2.27
.30	.154	.31	.49	.64	1.24	1.82	2.39
.31	.162	.32	.51	.68	1.30	1.92	2.52
.32	.170	.34	.54	.71	1.37	2.02	2.65
.33	.179	.36	.56	.74	1.44	2.12	2.78
.34	.187	.38	.59	.77	1.50	2.22	2.92
.35	.196	.39	.62	.80	1.57	2.32	3.06
.36	.205	.41	.64	.84	1.64	2.42	3.19
.37	.213	.43	.67	.88	1.72	2.53	3.34
.38	.222	.45	.70	.92	1.79	2.64	3.48
.39	.231	.47	.73	.95	1.86	2.75	3.62
.40	.241	.48	.76	.99	1.93	2.86	3.77
.41	.250	.50	.78	1.03	2.01	2.97	3.92
.42	.260	.52	.81	1.07	2.09	3.08	4.07
.43	.269	.54	.84	1.11	2.16	3.20	4.22
.44	.279	.56	.87	1.15	2.24	3.32	4.38
.45	.289	.58	.90	1.19	2.32	3.44	4.54
.46	.299	.61	.94	1.23	2.40	3.56	4.70
.47	.309	.63	.97	1.27	2.48	3.68	4.86
.48	.319	.65	1.00	1.31	2.57	3.80	5.03
.49	.329	.67	1.03	1.35	2.65	3.92	5.20
.50	.339	.69	1.06	1.39	2.73	4.05	5.36
.51	.350	.71	1.10	1.44	2.82	4.18	5.53
.52	.361	.73	1.13	1.48	2.90	4.31	5.70
.53	.371	.76	1.16	1.52	2.99	4.44	5.88
.54	.382	.78	1.20	1.57	3.08	4.57	6.05
.55	.393	.80	1.23	1.62	3.17	4.70	6.23
.56	.404	.82	1.26	1.66	3.26	4.84	6.41
0.57	0.415	0.85	1.30	1.70	3.35	4.98	6.59
.58	.427	.87	1.33	1.75	3.44	5.11	6.77
.59	.438	.89	1.37	1.80	3.53	5.25	6.96
.60	.450	.92	1.40	1.84	3.62	5.39	7.15
.61	.462	.94	1.44	1.88	3.72	5.53	7.34
.62	.474	.97	1.48	1.93	3.81	5.68	7.53
.63	.485	.99	1.51	1.98	3.91	5.82	7.72
.64	.497	1.02	1.55	2.03	4.01	5.97	7.91
.65	.509	1.04	1.59	2.08	4.11	6.12	8.11
.66	.522	1.07	1.63	2.13	4.20	6.26	8.31
.67	.534	1.10	1.66	2.18	4.30	6.41	8.51
.68	.546	1.12	1.70	2.23	4.40	6.56	8.71
.69	.558	1.15	1.74	2.28	4.50	6.71	8.91
.70	.571	1.17	1.78	2.33	4.60	6.86	9.11
.71	.584	1.20	1.82	2.38	4.70	7.02	9.32
.72	.597	1.23	1.86	2.43	4.81	7.17	9.53
.73	.610	1.26	1.90	2.48	4.91	7.33	9.74
.74	.623	1.28	1.94	2.53	5.02	7.49	9.95
.75	------	1.31	1.98	2.58	5.12	7.65	10.2
.76	------	1.34	2.02	2.63	5.23	7.81	10.4
.77	------	1.36	2.06	2.68	5.34	7.97	10.6
.78	------	1.39	2.10	2.74	5.44	8.13	10.8
.79	------	1.42	2.14	2.80	5.55	8.30	11.0
.80	------	1.45	2.18	2.85	5.66	8.46	11.2
.81	------	1.48	2.22	2.90	5.77	8.63	11.5
.82	------	1.50	2.27	2.96	5.88	8.79	11.7
.83	------	1.53	2.31	3.02	6.00	8.96	11.9
.84	------	1.56	2.35	3.07	6.11	9.13	12.2
.85	------	1.59	2.39	3.12	6.22	9.30	12.4
.86	------	1.62	2.44	3.18	6.33	9.48	12.6
.87	------	1.65	2.48	3.24	6.44	9.65	12.8
.88	------	1.68	2.52	3.29	6.56	9.82	13.1
.89	------	1.71	2.57	3.35	6.68	10.0	13.3
.90	------	1.74	2.61	3.41	6.80	10.2	13.6
.91	------	1.77	2.66	3.46	6.92	10.4	13.8
.92	------	1.81	2.70	3.52	7.03	10.5	14.0
.93	------	1.84	2.75	3.58	7.15	10.7	14.3
.94	------	1.87	2.79	3.64	7.27	10.9	14.5
.95	------	1.90	2.84	3.70	7.39	11.1	14.8
.96	------	1.93	2.88	3.76	7.51	11.3	15.0
.97	------	1.97	2.93	3.82	7.63	11.4	15.2
.98	------	2.00	2.98	3.88	7.75	11.6	15.5
.99	------	2.03	3.02	3.94	7.88	11.8	15.8
1.00	------	2.06	3.07	4.00	8.00	12.0	16.0
1.01	------	2.09	3.12	4.06	8.12	12.2	16.2
1.02	------	2.12	3.17	4.12	8.25	12.4	16.5
1.03	------	2.16	3.21	4.18	8.38	12.6	16.8

[1] Letters, H_A and W, refer to Figure 2. To convert decimal fractions of a foot to inches and fractions, set corresponding units in Table 2.

TABLE 6.—*Free flow discharge through Parshall measuring flume*—Continued.

Head, H_A	Discharge, Q, for throat widths, W, of—							Head, H_A	Discharge, Q, for throat widths, W, of—						
	0.25 foot	0.50 foot	0.75 foot	1 foot	2 feet	3 feet	4 feet		0.25 foot	0.50 foot	0.75 foot	1 foot	2 feet	3 feet	4 feet
Feet	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Feet*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
1.04		2.19	3.26	4.25	8.50	12.8	17.0	1.22		2.82	4.16	5.41	10.9	16.4	21.9
1.05		2.22	3.31	4.31	8.63	13.0	17.3	1.23		2.86	4.22	5.48	11.0	16.6	22.2
1.06		2.26	3.36	4.37	8.76	13.2	17.5	1.24		2.89	4.27	5.55	11.2	16.8	22.5
1.07		2.29	3.40	4.43	8.88	13.3	17.8	1.25			4.32	5.62	11.3	17.0	22.8
1.08		2.32	3.45	4.50	9.01	13.5	18.1	1.26			4.37	5.69	11.4	17.2	23.0
1.09		2.36	3.50	4.56	9.14	13.7	18.3	1.27			4.43	5.76	11.6	17.4	23.3
1.10		2.40	3.55	4.62	9.27	13.9	18.6	1.28			4.48	5.82	11.7	17.7	23.6
1.11		2.43	3.60	4.68	9.40	14.1	18.9	1.29			4.53	5.89	11.9	17.9	23.9
1.12		2.46	3.65	4.75	9.54	14.3	19.1	1.30			4.59	5.96	12.0	18.1	24.2
1.13		2.50	3.70	4.82	9.67	14.5	19.4	1.31			4.64	6.03	12.2	18.3	24.5
1.14		2.53	3.75	4.88	9.80	14.7	19.7	1.32			4.69	6.10	12.3	18.5	24.8
1.15		2.57	3.80	4.94	9.94	14.9	19.9	1.33			4.75	6.18	12.4	18.8	25.1
1.16		2.60	3.85	5.01	10.1	15.1	20.2	1.34			4.80	6.25	12.6	19.0	25.4
1.17		2.64	3.90	5.08	10.2	15.3	20.5	1.35			4.86	6.32	12.7	19.2	25.7
1.18		2.68	3.95	5.15	10.3	15.6	20.8	1.36			4.92	6.39	12.9	19.4	26.0
1.19		2.71	4.01	5.21	10.5	15.8	21.0	1.37			4.97	6.46	13.0	19.6	26.3
1.20		2.75	4.06	5.28	10.6	16.0	21.3	1.38			5.03	6.53	13.2	19.9	26.6
1.21		2.78	4.11	5.34	10.8	16.2	21.6	1.39			5.08	6.60	13.3	20.1	26.9

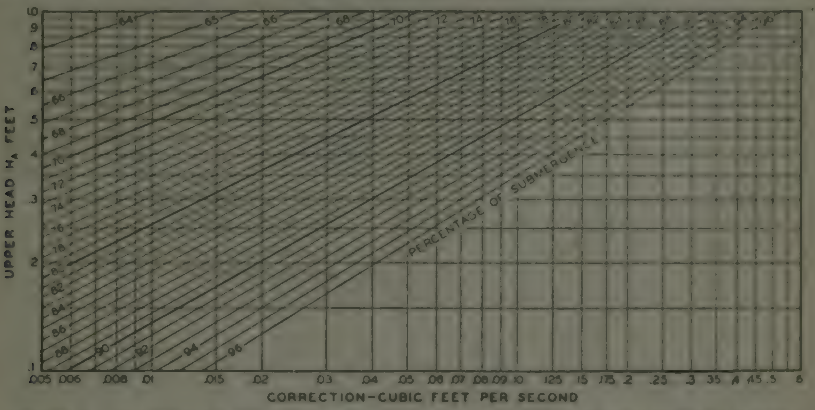


FIGURE 3.—Diagram for computing submerged flow through 0.25-foot Parshall measuring flume

SUBMERGED FLOW

When the ratio of H_B to H_A readings exceeds 0.7 for flumes of 1 foot and larger in size, and 0.6 for those less than 1 foot, it becomes necessary to apply a correction to the free-flow discharge as given in Table 6 in order to determine the rate of the submerged flow. This computed submerged flow is determined by the use of the diagrams shown in Figures 3, 4, 5, and 6. The correction diagram for the 1-foot flume (fig. 6) may be used for larger flumes by multiplying the correction for the 1-foot flume by the factor given below for the particular flume.

Size of flume (W) feet	Multiplier
1	1.0
2	1.8
3	2.4
4	3.1

For example, suppose the head on the H_A gauge of a 3-foot Parshall measuring flume is 1.34 feet, and on the H_B gauge it is 1.21 feet. The ratio $\frac{1.21}{1.34}$ is approximately 0.90 or 90 per cent. At the left margin of the diagram (fig. 6) find the number 1.34 and follow the horizontal line to where it intersects the curve for 90 per cent submergence. Then follow down the vertical line to the bottom of the diagram. This shows the correction for a 1-foot flume to be

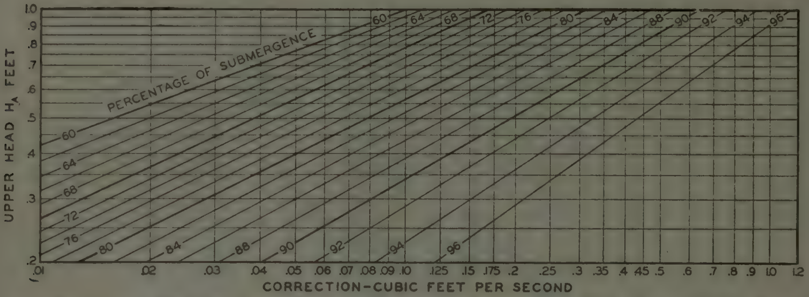


FIGURE 4.—Diagram for computing submerged flow through 0.50-foot Parshall measuring flume

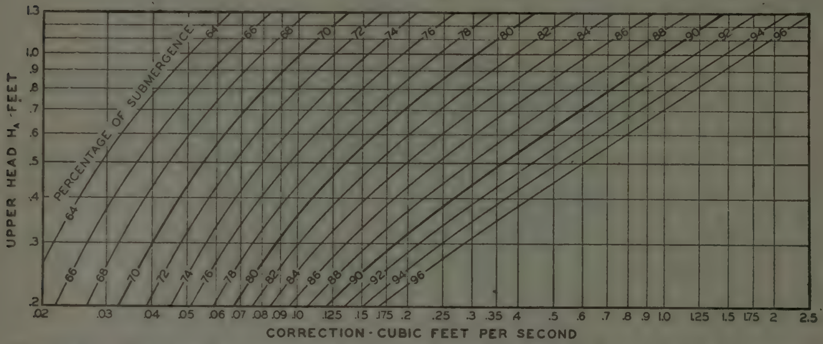


FIGURE 5.—Diagram for computing submerged flow through 0.75-foot Parshall measuring flume

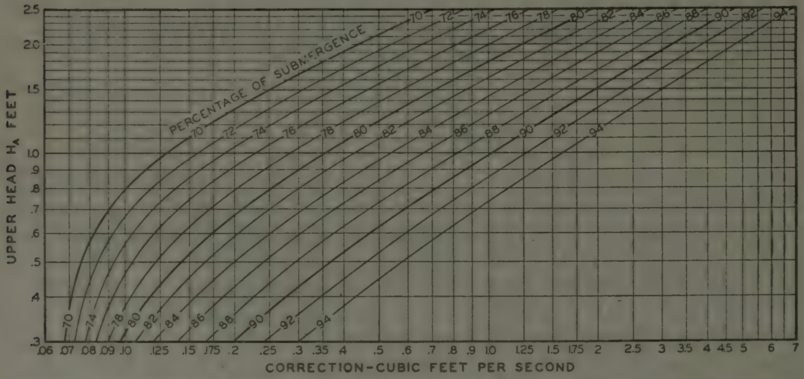


FIGURE 6.—Diagram for computing submerged flow through 1-foot Parshall measuring flume

about 1.6 second-feet. The correction for the 3-foot flume is found by multiplying 1.6 by 2.4, which gives 3.84 second-feet. From Table 6 it is found that the free-flow discharge for a 3-foot flume with an upper head (H_A) of 1.34 feet is 19.0 second-feet. For submerged flow, therefore, the discharge is 19.0 − 3.8 or 15.2 second-feet.

Again, for a submerged flow through a 0.5-foot flume, when H_A is 0.72 foot and H_B is 0.59 foot, the ratio is approximately 0.82, and the correction (fig. 4) is 0.18 second-foot. From Table 6 the free-flow discharge for the head (H_A) of 0.72 foot is found to be 1.23 second-feet, and the submerged flow is 1.23 − 0.18 = 1.05 second-feet.

SETTING AND SIZE

Successful operation of the Parshall flume depends upon setting the crest at the correct elevation with reference to the bed of the channel. Where sufficient fall is available this setting may be determined with little difficulty, but if the fall is slight care must be taken in fixing the height of the crest so that if possible the degree of submergence shall not exceed the limits of free-flow operation as explained on page 9. In all cases it is necessary to set the crest so that the submergence shall not exceed the practical limitation of about 95 per cent since the flume will not measure accurately if the degree of submergence exceeds this limitation. The elevation of the crest depends upon the quantity of water to be measured and the size of flume to be used.

For example, let it be desired to measure 12 second-feet in a channel of moderate grade, with a depth of water of 1.5 feet at the point where the flume is to be located. This quantity can be measured through several sizes of flume, but from the standpoint of economy the smallest practical size should be selected. Assume that a submergence of 70 per cent shall not be exceeded in order that the flow may be determined by the single gauge H_A. First, consider a 3-foot flume. For a discharge of 12 second-feet (Table 6) it will be noted that the upper head, H_A, is 1 foot. For a submergence of 70 per cent, the ratio of H_B gauge to H_A gauge is 0.7: whence H_B for this condition of flow is found to be 0.7 foot. The loss of head or difference in elevation between the water surfaces upstream and downstream will therefore be approximately 0.3 foot. Since the depth of the water downstream has been assumed to be 1.5 feet, the depth upstream will be greater by 0.3 foot, the loss in head, or 1.8 feet. Now, since the H_A head is 1.0 foot, it is apparent that the level floor of the converging section must be set 0.8 foot above the bed of the channel.

Next, consider a 2-foot flume. Here the upper head (H_A) is 1.30 feet for a free-flow discharge of 12 second-feet. The H_B head for 70 per cent submergence would be 1.30 × .70, or 0.91, and the loss of head about 0.4 foot. For this condition, the depth of water upstream from the flume would be about 1.9 feet, and the elevation of the crest would be 0.6 foot above the bed of the channel.

Similarly, for a 1-foot flume to measure 12 second-feet for a 70 per cent submergence, the loss of head is approximately 0.6 foot, and the crest elevation above the bed of the channel would be about 0.1 foot.

It is noted that as the size of flume decreases, the loss of head becomes greater, and the elevation of the floor of the flume above the bed of the channel becomes less. It is usually the better practice to set the flume high rather than low, as a margin of safety in allowing for variations of the water surface downstream from the structure. For the 1-foot flume setting, a loss of head of 0.6 foot may endanger the banks of the upper section of the channel. The 3-foot flume setting, in this case, requires an elevation of the floor above the bed of the channel of 0.8 foot, but the loss of head is the least of the three. It is concluded that the 2-foot flume is the most practical installation to meet the conditions.

In some cases it may be impracticable to set the flume to operate under a free-flow condition, because of insufficient available fall, and it will then become necessary to use both the H_A and H_B gauges, as previously explained. The flume may be placed so as to operate at any desired degree of submergence.

For example, let it be required to use a 3-foot flume to measure 12 second-feet at a submergence of 90 per cent. To arrive at the proper elevation of the crest above the bottom of the channel, it is necessary to refer to Figure 6. For the submerged flow of 12 second-feet, the value of H_A will be somewhat greater than for free flow. Try H_A at 1.2 feet. The free-flow discharge for this head will be found to be 15.96 second-feet. The diagram shows that the correction for 90 per cent submergence for H_A at 1.2 feet is about 1.35 second-feet for a 1-foot flume, and that for the 3-foot flume will be 2.4 times 1.35, or 3.24 second-feet. This amount subtracted from the free flow of 15.96 second-feet will give a submerged flow of 12.72 second-feet. This assumption shows that the value of H_A is too large.

For H_A at 1.16 feet, the computed submerged discharge will be found to be approximately 12.02 second-feet, which is close enough for the purpose. For this condition the loss of head will be 10 per cent of the upper head (H_A), or approximately 0.12 foot. This loss of head added to the depth of water downstream will be 1.62 feet, or the depth of water upstream. Since the value of the H_A head is 1.16 feet, the crest elevation will be the difference, or 0.46 foot.

CONSTRUCTION

The Parshall measuring flume may be built of timber, of concrete, or, in the smaller sizes, of sheet metal. The dimensions for the various sizes of flumes are given in Table 5, in which several columns are headed by capital letters referring to the corresponding dimensions shown in Figure 2. In the construction of this flume it is necessary to build to exact dimensions, especially the converging and throat sections.

For a flume made of lumber, sills and posts should be of ample size, with substantial cross bracing. Figure 2 presents a plan for a framed structure, with 4 by 4 inch sills and posts and common 2-inch plank for the walls and floor. For the larger flumes, 4 by 6 inch posts and sills, with 3-inch surfaced plank will be found to be more satisfactory. Treating the material with appropriate preservatives will lengthen the life of the structure. The bottom wall planks should be placed before the floor is laid. This will prevent the sides from crowding or bulging in at the bottom and thus materially altering the inside dimensions of the flume. It is recommended that a ⅛-inch space be left between planks when placing the floor and walls, to allow for swelling.

It is essential that the crest be straight and level, and also that the floor of the converging section be level in both directions. An angle-iron crest, as indicated in Figure 2, is strongly recommended. This metal piece, which insures a true and definite edge, should be gained in to set flush with the floor line, and should be firmly held in place by substantial screws with countersunk heads.

Suitable wing walls should be provided at the ends of the structure. Those at the upstream end should be built at angles of about 45° with the axis of the flume. In the smaller flumes the downstream wings may be extended to the sides of the channel at right angles to the flume. It is best to provide a short, inclined floor, with a slope of about 1 to 4, laid flush with the upper end of the floor of the converging section of the flume, as shown in Figure 2. If the material in the bed of the channel is soft, either stone riprap or a wooden apron should be provided at the downstream end of the structure to prevent erosion of the bed and banks.

The construction of this flume in sheet metal for the 0.25, 0.50, 0.75, 1, and 2 foot sizes has proved to be very satisfactory, but the cost somewhat exceeds that of concrete or wood. The metal flume has advantages in that it is portable, can be readily set, and is relatively long-lived. Use of factory-made flumes should assure accuracy of dimensions and uniform construction.

Concrete is preferable for the larger flumes but costs somewhat more than timber. It is durable and is little subject to expansion and contraction, thus insuring uniformity in operation. The method of construction is that of ordinary reinforced-concrete work of a monolithic nature.

STILLING WELLS AND GAUGES

The rate of flow is determined by the water depths in the converging and throat sections of the flume. The stream of water flowing through the device varies slightly in depth, due to the pulsations naturally set up in the moving water. A staff gauge set vertically at the proper point on the inside of the converging wall can be read as the upper head (H_A) with a fair degree of accuracy, while placing such a gauge on the inside of the throat section to observe the lower head (H_B) would be found to be impracticable because of the roughness of the water surface.

For best results, it is recommended that these heads or depths of water be observed in special compartments or stilling wells set just outside of the flume, with small inlet tubes connecting the wells with the flume. The staff gauge is set vertically on the inside face of the stilling well, with the zero or initial point of the graduated scale level with the crest. It is preferable to have this gauge graduated in feet, and tenths and hundredths of a foot, rather than in feet and inches.

The stilling well (fig. 7) should be of sound material, constructed with sides and bottom, and be set vertically, close to the outside of the flume, as shown in Figure 2. At a point two-thirds of the length of the converging section, back from the crest (Table 5, ⅔ A), insert a tightly fitting 1-inch tube in the H_A stilling well, with the center of the tube about 1½ inches above the floor line. The tube should be long enough to reach through the side wall of the well and should be carefully placed with its end flush with the inside face of the flume wall.

Figure 2 also shows the location of the tube for the throat connection with the H_B stilling well. The light is strong enough in the stilling well for easy reading of the graduations on the staff gauge, and the sloping sides aid in withdrawing the accumulated deposits from the bottom of the well. The bottom of the well should be about 1 foot below the floor line of the flume to catch the deposits of silt without interfering with the passage of water through the inlet tube.

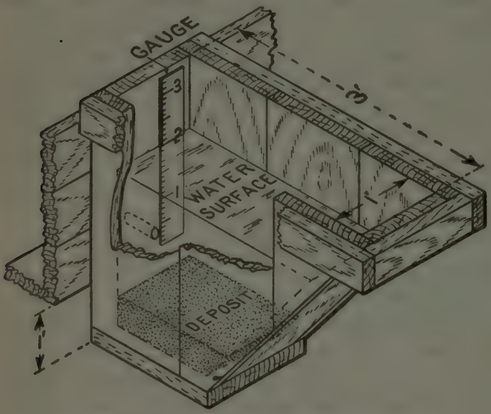


FIGURE 7.—Stilling well with staff gauge

This type of stilling well is also suited to the operation of recording instruments, but where such an instrument is to be used the well must be made about 2 feet wide to allow sufficient room for the float. A Parshall measuring flume with a water-stage recording instrument set over a stilling well is shown on the cover. The ordinary single-stage recorder is adapted to free-flow conditions only. Where the flow is submerged, a special, double-head recording instrument is necessary and here the H_A and H_B, stilling wells may be combined in a single well having a water-tight partition or diaphragm with suitable pipes leading to the proper inlet points in the flume.

VELOCITY OF APPROACH

For some types of measuring devices, such as the weir, it is known that when the stream of water approaches the section of measurement at a greater rate of speed than the standard or correct velocity, the actual discharge is greater than the indicated discharge. This difference is not great for moderate velocities of approach, but if the rate be greatly increased a very marked effect upon the discharge will result.

The velocity of approach, in the case of the weir, is materially affected by deposits of sand and silt upstream from the weir, causing a reduced section through which the water must pass and thus increasing the velocity of its approach. Laboratory tests on a 2-foot Parshall measuring flume show no effect in the indicated rate of discharge for an increase of 85 per cent in the velocity of approach, whereas for a 2-foot rectangular weir with a head of 1.0 foot, it is found that an increase in the velocity of approach of 85 per cent results in an actual rate of flow about 3.4 per cent greater than the indicated flow.

LOSS OF HEAD

The weir, operated under standard conditions of setting, is the most accurate of the more practical devices, but it requires in its operation a relatively large loss of head. Table 7 gives a comparison of the loss of head for the Parshall measuring flume with three types of weirs.

It is to be noted in this comparison that the values given under the headings for the various weirs represent the actual heads or depths on the crest required to give corresponding discharges. In reality, the loss of head is greater than that indicated by the difference in elevation between the downstream water surface and the weir crest. This additional fall is necessary to permit the free passage of air underneath the nappe, or overpouring stream of water, and may be assumed to be from 0.05 to 0.1 foot. This comparison indicates that the loss of head required in the use of weirs is approximately four times as great as that needed for the Parshall flume where the crest length of weir and flume are the same and the flow through the flume is submerged to the free-flow limit.

Table 7.—*Comparison of loss of head in feet for equal discharges through Parshall measuring flume, and over weirs*

Discharge	Loss of head of Parshall measuring flume				Loss of head of rectangular weir				Loss of head of Cipolletti weir				Loss of head of 90° triangular-notch weir
	6-inch	1-foot	2-foot	4-foot	6-inch	1-foot	2-foot	4-foot	6-inch	1-foot	2-foot	4-foot	
Sec.-ft.	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
0.10	0.06				0.15				0.15				0.27
.50	.16	0.08			.46	0.29	0.18		.43	0.28	0.18		.52
1.00	.25	.12	0.08		.74	.46	.29	0.18	.64	.44	.28	0.18	.69
2.00	.41	.19	.12	0.08	1.16	.75	.46	.29	.96	.60	.45	.28	.92
3.00		.25	.16	.11		.99	.61	.38		.88	.58	.37	1.08
5.00		.35	.22	.14			.86	.53			.82	.52	1.32
7.50		.45	.29	.19			1.13	.70			1.06	.68	
10.00		.55	.35	.22				.85			1.27	.83	
12.50		.63	.40	.26				.99				.96	
15.00			.45	.29				1.12				1.08	
20.00			.54	.35				1.36				1.31	

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	ARTHUR M. HYDE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel and Business Administration.	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Solicitor	E. L. MARSHALL.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	R. Y. STUART, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Public Roads	THOMAS A. MACDONALD, *Chief.*
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Plant Quarantine and Control Administration	LEE A. STRONG, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*

U. S. GOVERNMENT PRINTING OFFICE: 1932

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1684

GAME LAWS

FOR THE SEASON 1931-32

A Summary of the Provisions of Federal, State, and Provincial Statutes

THE thirty-second annual summary by the Department of Agriculture of Federal and other game laws and regulations is here presented for the use of law-enforcement officials, sportsmen, conservationists, and others as an aid in the administration of the migratory-bird treaty and Lacey acts. The provisions as set forth furnish a brief and convenient synopsis of the laws. Provisions relating to methods of capture, game refuges, enforcement of laws, disposition of fees and fines, and minor matters are omitted, as also are texts of Federal and Canadian laws and regulations relating to birds and game. Illustration on the title-page of this bulletin is of blue-winged teal (*Querquedula discors*) from a drawing by E. L. Poole.

Washington, D. C. Issued September, 1931

OFFICIALS FROM WHOM COPIES OF GAME LAWS MAY BE OBTAINED AND TO WHOM VIOLATIONS MAY BE REPORTED

[Violations of Federal game laws may be reported to the Chief, Bureau of Biological Survey, United States Department of Agriculture, Washington, D. C., or to the nearest United States game or reservation protector, a list of whom appears on page 52]

Federal laws: Secretary of Agriculture, Washington, D. C.
Alabama: Department of Game and Fisheries, Montgomery.
Alaska: Executive Officer, Alaska Game Commission, Juneau; or Secretary of Agriculture, Washington, D. C.
Arizona: State Game Warden, Phoenix.
Arkansas: Secretary, Game and Fish Commission, Little Rock.
California: Executive Officer, Fish and Game Commission, Russ Building, San Francisco.
Colorado: State Game and Fish Commissioner, Denver.
Connecticut: Superintendent of Fisheries and Game, Hartford.
Delaware: Chief Game and Fish Warden, Dover.
District of Columbia: Superintendent Metropolitan Police, Washington.
Florida: State Game Commissioner, Tallahassee.
Georgia: Game and Fish Commissioner, Atlanta.
Hawaii: Executive Officer, Fish and Game Commissioners, Honolulu.
Idaho: Fish and Game Warden, Boise.
Illinois: Director, Department of Conservation, Springfield.
Indiana: Superintendent of Fisheries and Game, State House, Indianapolis.
Iowa: State Fish and Game Warden, Des Moines.
Kansas: State Fish and Game Warden, Pratt.
Kentucky: Executive Agent, Game and Fish Commission, Frankfort.
Louisiana: Commissioner of Conservation, Court Building, New Orleans.
Maine: Commissioner of Inland Fisheries and Game, State House, Augusta.
Maryland: State Game Warden, 512 Munsey Building, Baltimore.
Massachusetts: Director, Division of Fisheries and Game, 20 Somerset Street, Boston.
Michigan: Director, Department of Conservation, Lansing.
Minnesota: Game and Fish Commissioner, Department of Conservation, St. Paul.
Mississippi: Secretary of State, Jackson; or Sheriff or County Clerk.
Missouri: Game and Fish Commissioner, Jefferson City.
Montana: State Fish and Game Warden, Helena.
Nebraska: State Game Warden, Lincoln.
Nevada: Secretary, State Fish and Game Commission, Reno.
New Hampshire: Fish and Game Commissioner, Concord.
New Jersey: Secretary, Board of Fish and Game Commissioners, Trenton.
New Mexico: State Game Warden, Santa Fe.
New York: Chief Division of Fish and Game, Department of Conservation, State Office Building, Albany.
North Carolina: Director, Department of Conservation and Development, Raleigh.
North Dakota: Game and Fish Commissioner, Bismarck.
Ohio: Conservation Commissioner, Department of Agriculture, Columbus.
Oklahoma: State Fish and Game Warden, Oklahoma City.
Oregon: State Game Commission, 616 Oregon Building, Portland.
Pennsylvania: Executive Secretary, Board of Game Commissioners, Harrisburg.
Rhode Island: Chairman, Commissioners of Birds, Providence.
South Carolina: Chief Game Warden, Columbia.
South Dakota: Director, Game and Fish Commission, Pierre.
Tennessee: State Game and Fish Warden, Nashville.
Texas: Game, Fish, and Oyster Commission, Austin.
Utah: Fish and Game Commissioner, Salt Lake City.
Vermont: Fish and Game Commissioner, Montpelier.
Virginia: Executive Secretary, Commission of Game and Inland Fisheries, Richmond.
Washington: Supervisor of Game and Game Fish, 404 Bell Street Terminal (P. O. Box 384), Seattle.
West Virginia: Game, Fish, and Forestry Commission, Charleston.
Wisconsin: Conservation Director, Madison.
Wyoming: State Game and Fish Commission, Cheyenne.
Canada: Commissioner, National Parks of Canada, Ottawa.
Alberta: Game Commissioner, Edmonton.
British Columbia: Game Commissioner, 411 Dunsmuir Street, Vancouver.
Manitoba: Director of Game and Fisheries, Winnipeg.
New Brunswick: Chief Game Warden, Fredericton.
Northwest Territories: Director, Northwest Territories and Yukon Branch, Department of Interior, Ottawa, Ontario.
Nova Scotia: Minister of Lands and Forests, Halifax.
Ontario: Department of Game and Fisheries, Toronto.
Prince Edward Island: Game Inspector, Provincial Treasury Department, Charlottetown.
Quebec: General Superintendent of Fisheries and Game, Quebec.
Saskatchewan: Game Commissioner, Regina.
Yukon: Territorial Secretary, Dawson.
Newfoundland: Secretary, Game and Inland Fisheries Board, St. Johns.
Mexico: Secretaria de Agricultura y Fomento, San Jacinto, Federal District.

GAME LAWS FOR THE SEASON 1931-32

A SUMMARY OF FEDERAL, STATE, AND PROVINCIAL STATUTES

By H. P. Sheldon, *United States Game Conservation Officer, in Charge*, and Frank G. Grimes, *Junior Administrative Assistant, Division of Game and Bird Conservation, Bureau of Biological Survey*

CONTENTS

Page
Introduction 1
  Proclamation of the President 1
Federal wild-life refuges 2
Review of legislation of 1931 3
  Federal regulations 3
  State and Provincial legislation, 1931 3
Federal laws relating to migratory birds 8
  Open seasons under Federal regulations 8
  Bag limits and other provisions under Federal regulations 10
Summary of laws relating to seasons, licenses, limits, possession, transportation, and sale 12
  State laws 13
  Canada 44
  Newfoundland 48
  Mexico 49
Imported game and game raised in captivity 49
Field service, Division of Game and Bird Conservation, Bureau of Biological Survey 52

INTRODUCTION

The following proclamation has been issued by the President of the United States in the interests of the conservation of our waterfowl:

BY THE PRESIDENT OF THE UNITED STATES OF AMERICA

A PROCLAMATION

The long-continued and severe drought of the past two years has inflicted not only economic hardships by seriously curtailing crop and stock production, but also has resulted in an emergency condition as regards the present and future safety and abundance of the waterfowl of the continent. In large areas of the United States and Canada, through lack of the water on breeding grounds essential to rearing the young birds, the drought has entailed widespread destruction among the former hordes of the wild fowl that migrate to our several States.

This devastation has constituted so great a menace to our wild-life resources and to their future enjoyment by our people as to impel the Secretary of Agriculture to adopt a regulation compatible with the migratory bird treaty act (40 Stat. 755), whereby during the coming fall there will be an open hunting season on these birds of only one month.

Now, THEREFORE, I, HERBERT HOOVER, President of the United States of America, do hereby urge that all persons take cognizance of this emergency, and I call upon all game and conservation officials, State and local, all members of game-protective organizations, landowners, sportsmen, and public-spirited citizens generally to lend their cooperation to effect full observance of this regulation, to the end that adequate numbers of waterfowl may return to their breeding grounds next spring and that there may be no repetition of the calamity of extermination that has already overtaken some species of our American birds.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the seal of the United States to be affixed.

Done at the City of Washington this 25th day of August, in the year of our Lord nineteen hundred and thirty-one, and of the Independence of the United States of America the one hundred and fifty-sixth.

HERBERT HOOVER.

By the President:
W. R. CASTLE, Jr.,
Acting Secretary of State.

Never before—certainly not within the memory of present-day sportsmen—have the wildfowl of our country been confronted with such threatening conditions as during the last two years. From time to time the Bureau of Biological Survey has called attention to the steady diminution in the numbers of waterfowl, especially the ducks, and to the necessity of saving annually sufficient breeding stocks to insure future sport. The department has imposed restrictions of various kinds designed to aid in the maintenance of these species by reducing the annual kill. The establishment of refuges and the propagation and liberation of those species that readily yield to domestication (chiefly mallards and Canada geese) are means of aiding in the restoration of the birds, but they are inadequate to meet an emergency that requires immediate remedy. In addition to the enormous annual kill by gunners, tremendous losses have, within the last two years, been inflicted on the birds by a most serious drought in the vast feeding and breeding areas in the northwestern United States and western Canada by the drying up of the lakes, ponds, and sloughs that were the favorite haunts of the nesting birds and furnished food, cover, and protection for the young broods.

So serious has the situation become that the Secretary of Agriculture adopted amendments to the regulations under the migratory-bird treaty act, which were approved by the President on August 25 and September 12, 1931, curtailing to one month the season for the shooting of ducks, geese, brant, and coot. The President supplemented his approval with the proclamation above quoted. If the sport of wildfowling is to be perpetuated for future generations, sportsmen of to-day must sacrifice at least a portion of their shooting privileges, and the appeal of the President for cooperation should meet with instant and generous response.

FEDERAL WILD-LIFE REFUGES

Following the inception of work under the migratory-bird conservation act of February 28, 1929, the Biological Survey began investigations of the food resources of proposed refuge areas, existing and potential, on more than 200 units, aggregating more than 4,000,000 acres. Intensive examinations, including valuation of areas embraced within desirable units, to determine correctly the types of land, the uses to which put, the ownership, and the character, extent, and value of existing improvements, have been made on 115 areas containing more than 3,000,000 acres of land and water.

As a result of these investigations four units, aggregating 65,000 acres of public lands in Montana, Oklahoma, California, and Nevada have been established by Executive order as wild-life refuges. The Migratory Bird Conservation Commission has approved for lease and purchase 111,517 acres of land in six units in California, Colorado, Florida, Nebraska, North Carolina, and South Carolina. The total area thus far acquired for inviolate sanctuaries for migratory birds is 176,244 acres. Negotiations for the acquisition of additional areas are in progress, and lands are being acquired for refuges as rapidly as the funds permit.

The Bureau of Biological Survey now administers 92 big-game and bird reservations. Among the most important of these from the viewpoint of their value as breeding, feeding, and nesting grounds for migratory birds are the Upper Mississippi River Wild Life and Fish Refuge, under joint administration with the Bureau of Fisheries, the Bear River Migratory Bird Refuge, Utah, and the bird refuges at Big Lake, Ark., Malheur and Upper Klamath Lakes, Oreg., Tule Lake, Calif., and Benton Lake, Mont. In addition, there were created by Executive order since the last bulletin on the game laws was published the Fallon Wild Life Refuge, Nev., the Crescent Lake Wild Life Refuge, Nebr., and the Charles Sheldon Wild Life Refuge, Nev. The last named is an area of more than 30,000 acres of public lands in Washoe County set aside by Executive order, and is primarily a refuge for antelope and sage grouse. The Cape Romaine Migratory Bird Refuge in South Carolina, and the St. Marks Migratory Bird Refuge in Florida will also be valuable bird sanctuaries when they are brought under full administration.

Of the 81 game and bird reservations established by Executive order, hunting has heretofore been permitted, under orders of the Secretary of Agriculture, on parts of 8. Because of emergency conditions confronting wild fowl as a result of the long-continued drought, and in line with the President's proclamation of August 25 shortening the season on ducks, geese, brant, and coot to one month, the Secretary of Agriculture, on August 28, 1931, revoked the orders permitting hunting on the following bird reservations: Salt River, Ariz.; Big Lake, Ark.; Tule Lake, Calif.; Deer Flat, Idaho; Nine Pipe and Pablo, Mont.; Rio Grande, N. Mex.; and Cold Springs, Colo.

REVIEW OF LEGISLATION OF 1931

FEDERAL REGULATIONS

Amendments to the Federal regulations under the migratory-bird treaty act were approved by the President on March 17, August 25, and September 12, 1931. The amendment of March 17 shortened the seasons throughout the country for the hunting of migratory waterfowl, including Wilson's snipe, or jacksnipe, and coot. In the Northern and Western States the season was fixed at October 1 to December 31; in the Southwest, October 16 to January 15; in the Southeastern States, November 1 to January 15, except in Florida, where the season was fixed to open November 20. These dates were further modified by the August and September amendments.

The March amendment closed the season entirely on Ross's goose and cackling goose throughout their range, and on snow geese in all the Atlantic Coast States. It also fixed the hour for the commencement of shooting on the opening day of the season at 12 o'clock noon instead of half an hour before sunrise. In the hunting of wild geese it provided that not more than 10 live-goose decoys might be used or shot over at any one gunning stand, blind, or floating device. The amendment also prohibited the hunting, killing, or taking of mourning doves on, over, or near any area baited with salt, corn, wheat, or other grain or with other foods. It specified further that nothing contained in the regulations should be deemed to permit the hunting or killing of migratory birds on any refuge established under the migratory-bird conservation act, or on any area of the United States set aside by any other law, proclamation, or Executive order for use as a wild-life refuge, except as permitted by the Secretary of Agriculture, or on any adjacent area closed to hunting under the migratory-bird treaty act.

The further shortening of the seasons by the amendments of August 25 and September 12, 1931, was necessary to meet an emergency situation confronting the waterfowl as a result of prolonged drought in the principal breeding areas of these birds in the northern Plains States westward to the Cascades and in the Prairie Provisions of Canada. These amendments supersede the amendment of March 17 only in so far as open seasons are concerned, all the other provisions of the earlier amendment remaining in full force and effect. The seasons prescribed by the August and September amendments are for one month only, as follows: October 1 to October 31 for the northern zone of the United States; November 16 to December 15 for the southern and Pacific zones, except that November 20 to December 19 is provided for Florida. Missouri, Iowa, Nebraska, Kansas, and Oklahoma were grouped with a season October 20 to November 19. Massachusetts, Rhode Island, Connecticut, and Illinois were given the season November 1 to November 30, and Ohio and Indiana, October 16 to November 15. In Alaska the season was fixed at September 1 to September 30.

Under the August amendment North Carolina was grouped with those States having a split season on mourning doves, the open season in that State now being September 1 to September 30, and November 20 to January 31.

No change having been made in the regulations on black-bellied and golden plovers, greater and lesser yellowlegs, wood duck, eider ducks, and swans, the season remains closed on these species. Wilson's snipe, or jacksnipe, and woodcock are the only shore birds that may be legally hunted.

STATE AND PROVINCIAL LEGISLATION, 1931

In 44 States this year sessions of the legislatures were held, and many laws were enacted affecting game. In some of the States, also, changes in the game laws were effected through order or by regulation of the game commissions.

POWERS OF ADMINISTRATIVE OFFICIALS

The power to restrict or prohibit entirely the hunting, killing, and possession of wild birds was vested in the Kansas Forestry, Fish, and Game Commission. In New Mexico the State game commission was given plenary power to define game animals and birds and game fish; to fix seasons and bag limits; and to prescribe the manner and means of hunting, and the devices which may be used. In North Carolina the board of conservation and development was empowered, provided 50 reputable citizens of the county petition such action, to permit the taking of one doe deer in the season limit of four in any county where, in its opinion, the ratio of does to bucks is such as to affect injuriously their progeny.

The Iowa Legislature, by act approved April 8, 1931, created a State game and fish commission of five members, to be appointed by the governor, and authorized the commission to regulate temporarily, or to shorten or close, seasons on any species of fish, game, fur animal, or protected bird. The legislature also by joint resolution of March 28, 1931, directed the State board of conservation and the fish and game department to enter into contract with a competent and reputable firm or individual park expert and regional planning engineer, to provide within two years a comprehensive state-wide park, fish, and game program, with necessary plans and specifications, and to submit cost of construction based on economic engineering principles, and appropriated $25,000 for this part of the work.

In Nebraska the game, forestation, and parks commission was authorized to issue hunters' "shooting scrip," consisting of books of detachable coupons, each stamped with its value. Persons desiring to hunt upland game birds on land where hunting is permitted are to leave the scrip book with the owner or lessee and at the conclusion of the day's shooting pay the landowner with the scrip, giving him one coupon for each bird killed. The value of the coupons is fixed by the commission at not to exceed 50 cents each. The scrip books are sold to resident and nonresident hunters, and the funds are held as a trust for the redemption of the coupons when presented by the landowner or lessee to the Commission. Unused coupons are redeemed at face value. Hunters using the scrip are subject to all existing game laws, including the procuring of the usual hunting license.

MISCELLANEOUS PROVISIONS

Arkansas, Colorado, Georgia, Kansas, Maine, North Carolina, and Minnesota enacted laws to bring the State game laws into conformity with Federal regulations under the migratory-bird treaty act, and Arkansas prohibited the shooting of game birds on baited areas. Indiana, Massachusetts, Missouri, New Jersey, North Dakota, and Oregon enacted laws consenting to the acquisition of lands by the United States for the creation of game-bird refuges within their boundaries under the migratory-bird conservation act.

In Maine the legislature created a civil-serive commission, composed of three members of the advisory council of the department of inland fisheries and game, to draft and put into effect a civil-service code covering permanent employees of the department and the game-warden and fish-hatchery services.

The Kansas Legislature recognized by statute the ethics of sportsmanship by making it unlawful to shoot game birds on the ground or on water unless wounded, thus establishing wing-shooting as the standard of sport in that State. The only other State having a statute approaching this is Florida, which forbids the shooting of waterfowl while they are on the ground or water. A number of the States, however, prohibit the hunting of some or all species when the ground is covered with snow, North Carolina being added to this list this year.

The Nebraska Legislature passed an act reiterating State ownership of all upland game birds, but recognized that resident landowners or lessees should receive certain remuneration for the feeding and raising of upland game birds.

Kansas, Maryland, and Missouri removed protection from eagles, Missouri placing a bounty of 50 cents on them. Maryland discontinued the bounty on hawks.

SEASONS

BIG GAME

Deer.—Florida closed the season on deer in 2 counties. Georgia added 8 counties to the 18 closed to deer hunting and made the opening and closing dates 5 days later than formerly. In 7 counties in Maine the season was fixed at November 1 to December 15, and in 1 county at October 16 to November 30, the season of November 1 to 30 applying in the remainder of the State. Michigan closed the season in 2 counties where formerly it had been open, and opened it in 4 that were formerly closed. Missouri opened the season for 3 days in the State, while Montana closed it in 5 counties. New Hampshire shortened the season in 1 county; New Mexico advanced the 10-day season to open October 20 instead of November 10 and closed it in 1 county. In New York a 15-day season was prescribed in 1 county and the season in the Adirondack region was shortened, opening the sixth week day in October prior to November 1, instead of October 15, thus making the 1931 season in that region October 26 to November 15. North Carolina advanced the season to open September 15 instead of October 1 and authorized the board of conservation and development to permit the taking of does under certain conditions. In North Dakota the season was opened 10 days except in 17 counties and parts of 2, where it remains closed. Oregon set the season back 5 days, opening September 20 instead of September 15. In Pennsylvania the board of game commissioners rescinded the 2-day season on does. South Carolina closed the season in 1 county in addition to 4 that were previously closed and provided a season of 1 day only in 3 others. Tennessee opened the season in 5 counties that were formerly closed, and advanced the season throughout the State from December 20 to 31 to December 1 to 10, thus reducing it 2 days. Vermont deferred the opening of the season from November 10 to November 21, and continued indefinitely the closed season in 1 county. Virginia rescinded the local laws in 2 counties east of the Blue Ridge Mountains, making the general State season apply. A 5-day season was prescribed in 3 counties west of the Blue Ridge Mountains, and a closed season in 1. Wisconsin opened 3 counties that formerly were closed to deer hunting and closed 2 that formerly were open. Wyoming closed the season in 1 county, and increased it 2 days in 1 county by opening October 20 instead of November 1, and closing October 31 instead of November 10. British Columbia extended the season 3 days, opening September 12 and closing December 15, instead of September 1 to November 30, and made the season uniform in both districts. In New Brunswick the season was shortened 15 days, opening October 1 instead of September 15. Nova Scotia opened the season on does except on Cape Breton Island.

Bear.—California extended protection to black and brown bears in 2 districts where formerly they were unprotected. Georgia shortened the season 27 days, closing it on February 1 instead of on February 28. In Maine black bears were declared game animals and a general open season of November 1 to 30 was prescribed except in townships paying a bounty on them; in 7 counties, however, the season was fixed at November 1 to December 15, and in 1 county at October 16 to November 30, the general season applying in the rest of the State. In New Hampshire the season was lengthened 9 days by opening on October 1 instead of October 10. In the Adirondack region in New York the same bear season was prescribed as for deer. In 1 county in Oregon the season was opened for 1 month, November 1 to 30, thus extending partial protection to bears in 3 counties; in the remainder of the State they are unprotected. Pennsylvania shortened the bear season 9 days, opening on November 10 instead of November 1.

Elk, moose, and caribou.—Colorado opened the season on elk for 6 days, November 5 to 10, while Idaho shortened the seasons 9 days in 2 counties and 2 days in 1. Montana opened the elk season in 1 county, thus providing an open season in 5 counties and parts of 7 others. Vermont continued until 1942 the closed season on elk, moose, and caribou. In 2 counties in Wyoming the season on elk was extended by closing on November 30 instead of October 15, and advanced in 1 county from the period November 1 to 10 to the period October 20 to 31; the elk season was closed in 3 counties and changed in 1 county from October 15 to November 14 to October 1 to 31.

Mountain goat and mountain sheep.—In 10 counties in Idaho the season on mountain goat was shortened 15 days, opening 4 days later and closing 11 days earlier. The season on mountain sheep was closed entirely in 1 county in Wyoming, and shortened 30 days in another.

SMALL GAME ANIMALS

Rabbit.—Indiana shortened the season on rabbit by 42 days, opening November 11 instead of October 1. Maryland shortened the season 5 days, opening November 15 instead of November 10, while Michigan extended the season in the Lower Peninsula to close January 31 instead of January 1. New York shortened the season 11 days, opening (for 1931) October 26 instead of October 15, and prescribed the same opening date as for deer, the sixth week day in October prior to November 1. North Carolina removed protection from rabbits in 2 counties. Tennessee abolished all local laws and reenacted a local season for 1 county, removing protection entirely in 3. Wisconsin prescribed local seasons in 26 counties. Florida closed 1 county (Pinellas) to all hunting for 2 years.

Squirrel.—Arizona shortened the squirrel season 30 days, making it October 16 to November 15 instead of September 1 to October 31. Arkansas provided a split season of May 15 to June 15 and October 1 to January 1 for 4 additional counties, and the general season of July 1 to January 1 was applied to 8 counties where the season previously was October 1 to January 1; special seasons were prescribed in 6 counties, and protection was entirely removed in 10. Connecticut shortened the squirrel season 12 days, opening October 20 instead of October 8, while Indiana shortened it 17 days, closing October 14 instead of October 31. Kansas removed protection from fox squirrels. Maryland changed the season on squirrels in 2 counties from the period October 1 to November 9 to the period November 15 to December 24. Michigan provided separate seasons in the Upper and Lower Peninsulas instead of the uniform season previously in effect. New York shortened the season, to open (1931) October 26 instead of October 15, as in the case of deer. North Carolina provided a uniform season throughout the State of September 16 to December 31. Tennessee abolished local laws as in the case of rabbits and reenacted a local law for 1 county, and removed protection in 1. Texas changed the season in 6 counties and closed it entirely in 2. West Virginia cut off 30 days from squirrel hunting, opening October 15 instead of September 16. Florida closed 1 county to all hunting for 2 years, and Georgia shortened the season on cat squirrels 5 days except in 18 counties, where it was lengthened 46 days.

Fox.—North Carolina closed the season on foxes except in 5 counties. Oklahoma declared foxes game animals, and made it unlawful to kill them wantonly, but provided that they may be chased with dogs for sport.

UPLAND GAME BIRDS

Quail.—Arizona closed the quail season in 1 county. California changed the season from December 1 to 31 to November 15 to December 15. Connecticut opened the season from October 20 to November 23. Florida closed 1 county (Pinellas) to all hunting for 2 years. Georgia extended the season 4 days from the period November 20 to March 1 to the period October 1 to January 15. Maryland shortened the season, to open November 15 instead of November 10, and in 1 county extended the closed season on quail to 1933. Missouri closed the season in 6 counties. New Hampshire opened the season from October 15 to November 15. New Mexico shortened the season, opening November 10 instead of November 1 and closing December 10 instead of December 31, and in 2 counties closed the season entirely. Oregon opened the season in 9 counties. Tennessee abolished a number of local laws on upland game and enacted local laws on quail in 2 counties. Virginia shortened the season 61 days in 3 counties. West Virginia extended the season 16 days throughout the State, opening October 15 instead of November 1.

Grouse.—Arkansas made an open season on grouse of one month and 15 days on prairie chicken. California closed the season throughout the State on grouse and sage hen. The closed season on grouse was continued in Georgia. Idaho shortened the season on various species in certain counties. Maine extended the season by closing 9 days later. Maryland shortened the season 5 days and opened in 1 county (Garrett). Massachusetts opened the season October 20 to November 20 in 1 county (Dukes). In the Lower Peninsula of Michigan the season on grouse was extended to close October 26 instead of October 20. Minnesota prescribed a season of September 16 to October 31 for prairie chicken and sharp-tailed grouse. New Hampshire opened the grouse season in 1 county. New Mexico closed the season throughout the State. Oregon extended the grouse season from October 15 to 31 to the period September 30 to October 25 except in 3 counties, where the season is August 20 to September 20, and opened the season on sage hen 10 days in 2 counties. Pennsylvania extended the season on grouse from the period November 1 to 8 to 12 days—the open days being Mondays, Tuesdays, and Wednesdays of the first 2 weeks in November, and Thursdays, Fridays, and Saturdays of the last 2 weeks. Vermont opened the season October 1 to 31. Virginia shortened the season to 15 days in 2 additional counties. Wyoming made the season 15 days later in 1 county and lengthened it in another, from the last half of September to all of October and to November 15. Nova Scotia prescribed the grouse season of November 1 to 15 on Cape Breton Island, and Saskatchewan opened the season October 1 to 15 on prairie chicken and prairie hen.

Pheasant.—Arkansas prescribed an open season on pheasants from December 1 to 15. Connecticut extended until 1933 the closed season on Hungarian partridge. Georgia continued the closed season on native pheasant (ruffed grouse) but authorized landowners to permit the shooting of introduced pheasants from November 20 to February 15. Idaho shortened the season on various species in certain counties. Maryland shortened the season, to open November 15 instead of November 10 and opened the season in 1 county (Garrett). In Massachusetts the general season was applied also to Nantucket. Michigan opened the pheasant season October 1 to 12 in the Upper Peninsula and extended it to close 6 days later in the Lower Peninsula. In Minnesota the season was shortened, closing October 25 instead of November 1. One county was opened in New Hampshire. North Dakota provided a season of October 15 to November 1. Oregon extended the season on native pheasant (ruffed grouse) from October 15 to 31 to the period September 20 to October 25, except in 3 counties where the season is August 20 to September 20; and provided a season of October 15 to 31 for Chinese pheasant, except in 9 counties where it remains closed. In Pennsylvania the season was extended 15 days to close November 30 instead of November 15. Tennessee abolished all local laws respecting pheasants, except in 1 county, and with that exception closed the season throughout the State. Vermont extended the closed season on pheasant and European partridge until 1933.

Wild turkey.—Florida closed the wild-turkey season in 1 county until 1934. Maryland shortened the season to open November 15 instead of November 10 and extended to 1933 the closed season in Garrett County. Virginia shortened the season to 15 days in 2 additional counties.

Woodcock.—Michigan shortened the season on woodcock to 12 days, and North Dakota closed the season.

Doves.—Nebraska closed the season on doves throughout the State.

BAG LIMITS

Legislation on bag limits was enacted in about a third of the States and Provinces, and affected a number of species. On wild ducks, Vermont reduced the daily limit from 12 to 10, and the seasonal limit from 50 to 40. Nova Scotia and Prince Edward Island reduced the daily limit from 25 to 15, while Alberta reduced it from 30 a day and 200 a season to 15 a day during September and 25 a day for the remainder of the season, and prescribed a seasonal limit of 100. Alberta also reduced the limit on geese from 15 to 10 a day, and prescribed a seasonal limit of 25.

On quail, Connecticut fixed the limits at 3 a day, 10 a season; and New Hampshire at 5 a day. New Mexico reduced the limit from 15 to 12 a day. Tennessee continued the daily limit of 15 on quail, but reduced from 20 to 15 the limits on other upland game birds, except turkey.

Arkansas prescribed a daily limit of 3 on prairie chicken, and Pennsylvania a limit of 2 ruffed grouse a day, 12 a season. Vermont fixed a limit of 4 ruffed grouse a day, 25 a season. In Saskatchewan the daily limit on prairie chicken and prairie hen was fixed at 5 each, with not to exceed 10 of each in possession.

On pheasants, Arkansas fixed the daily limit at 3. New York increased the seasonal limit from 3 to 6, with a daily limit of 2.

Bag limits on other game birds were affected as follows: The daily limit was increased in New Mexico on doves from 20 to 25, and in Ohio was reduced on Hungarian partridge from 6 to 4.

On deer, Missouri prescribed a seasonal limit of 1. In Nova Scotia (except on Cape Breton Island) and in Saskatchewan the seasonal limit was increased to 2.

Pennsylvania prescribed a limit of 1 elk a season, 3 raccoons a day with 10 a season, and reduced the limit on hares from 5 a day and 30 a season, to 3 a day and 15 a season. Tennessee fixed a seasonal limit of 10 on squirrels. Oregon, having abolished the eastern and western districts, prescribed uniform bag limits and seasons throughout the State on all game.

LICENSES

License legislation has been chiefly concerned with modifying the fees for residents and nonresidents hunting and fishing. The most radical change was in Montana, where three classes of licenses were provided, as follows: Residents—class A, hunting game birds and fishing, $2; class AA, game animals, $1, in addition to the class A license; under a $5 "sportsman's license," the holder is entitled to hunt both game animals and birds, and to fish. Nonresidents—class B, or fishing license, $3.50; class B–1, to hunt game birds, $10; class B–2, general hunting and fishing, $30. Aliens—class C, fishing, $10; class C–1, game birds, $30; class C–2, game animals, $50; an alien is also required to procure a $25 gun license.

In West Virginia a combined hunting and fishing license, costing $15, was adopted for nonresidents; the fee for the resident hunting and fishing license was increased from $1.25 to $3, and a $1 county license was provided, authorizing the holder to hunt and fish in county of residence and adjoining counties; the $5 big-game license was abolished. Florida provided for a $2 license for residents hunting and fishing in one county, and a $5 license for nonresidents. Georgia prescribed a $10 county hunting license for nonresidents, good only in county of issue, and increased the resident State license from $3 to $3.25. In New York the fee for the combined hunting and fishing license for residents was increased from $1.25 to $2.25, and in Washington the fee for nonresidents hunting game birds from $5 to $15. South Dakota provided a separate small-game and fishing license for residents, costing $1 each.

The fee charged nonresidents for hunting in Kansas was cut from $15 to $7.50, and a resident State license was provided at $3, with a resident county license of $1, including hunting in adjoining counties. In Nova Scotia nonresidents hunting woodcock and jacksnipe must take out a $25 license.

Other provisions of license legislation included a requirement in New Jersey that licensees report the number of animals, birds, and fish taken under the previous year's license; and in Wisconsin that they submit an annual game census on forms accompanying licenses. Pennsylvania adopted a reciprocal game license for nonresidents, under which the applicant pays the same fee charged nonresidents in his State, but in no case less than $15. Taxidermists in North Dakota have their license fees increased from $1 to $2, and in Pennsylvania from $1 to $25.

License legislation affecting big-game hunting specifically was passed in two States. In Colorado a special elk license is provided, with fees of $50 for nonresidents, and $7.50 for residents, in addition to the regular hunting license, but persons to whom issued pay only the difference in cost between the two. In Wisconsin the cost of deer tags is increased from 50 cents to $1.

Separate fishing-license legislation was passed in eight States, as follows: In Florida a special $10 license is provided for nonresidents fishing on the Choctawhatchee River in three counties; Kansas provided a 15-day nonresident license, fee $1; Louisiana adopted a $1 weekly license for nonresidents, and Massachusetts a $3.25 seasonal license for the same class; North Dakota increased the fee for residents from 50 cents to $1; South Dakota raised the fee from $2 to $3; Ohio increased the resident license from $2.25 to $3.25; and in Washington the nonresident county license was increased from $2.50 to $3, and the 30-day tourist fishing license was abolished.

FEDERAL LAWS RELATING TO MIGRATORY BIRDS[1]

Migratory birds included in the terms of the convention between the United States and Great Britain for the protection of migratory birds, concluded August 16, 1916, are as follows:

1. *Migratory game birds:*

(*a*) Anatidae, or waterfowl, including brant, wild ducks, geese, and swans.

(*b*) Gruidae, or cranes, including little brown, sand-hill, and whooping cranes.

(*c*) Rallidae, or rails, including coot, gallinules, and sora and other rails.

(*d*) Limicolae, or shore birds, including avocets, curlews, dowitchers, godwits, knots, oyster catchers, phalaropes, plovers, sandpipers, snipe, stilts, surf birds, turnstones, willet, woodcock, and yellowlegs.

(*e*) Columbidae, or pigeons, including doves and wild pigeons.

2. *Migratory insectivorous birds:* Cuckoos; flickers and other woodpeckers; nighthawks or bullbats and whippoorwills; swifts; humming birds; flycatchers; bobolinks, meadow larks, and orioles; grosbeaks; tanagers; martins and other swallows; waxwings; shrikes; vireos; warblers; pipits; catbirds and brown thrashers; wrens; brown creepers; nuthatches; chickadees and titmice; kinglets and gnat catchers; robins and other thrushes; and all other perching birds which feed entirely or chiefly on insects.

3. *Other migratory nongame birds:* Auks, auklets, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and terns.

OPEN SEASONS UNDER FEDERAL REGULATIONS

Following are the provisions of the Federal regulations, with amendments of March 17 and August 25, 1931, fixing the open seasons on migratory game birds. Seasons on some of these species are further shortened by the provisions of State laws or regulations (for dates during which a person may hunt migratory game birds without violating either Federal regulations or State laws, reference should be had to the open seasons shown under the heading of each State, beginning on page 13).

---

[1] The full text of the migratory-bird treaty act and regulations and of other Federal laws affecting birds and game is contained in Service and Regulatory Announcement—B. S. No. 76, which may be obtained from the Department of Agriculture, Washington, D. C. Likewise the Canadian migratory-bird regulations may be obtained from the Commissioner, National Parks of Canada, Ottawa, Ontario.

Waterfowl (except snow geese in Florida and all States north thereof bordering on the Atlantic Ocean, Ross's goose, cackling goose, wood duck, eider ducks, and swans), and coot.—The open seasons for waterfowl (except snow geese in Florida and all States north thereof bordering on the Atlantic Ocean, Ross's goose, cackling goose, wood duck, eider ducks, and swans), and coot, shall be as follows: In Maine, New Hampshire, Vermont, New York (except Long Island), Pennsylvania, West Virginia, Michigan, Wisconsin, Minnesota, North Dakota, South Dakota, Colorado, Wyoming, Montana, Idaho, and Utah, the open season shall be from October 1 to October 31;

In Ohio and Indiana the open season shall be from October 16 to November 15;

In Massachusetts, Connecticut, Rhode Island, and Illinois the open season shall be from November 1 to November 30;

In Missouri, Iowa, Kansas, Nebraska, and Oklahoma the open season shall be from October 20 to November 19;

In that portion of New York known as Long Island, and in New Jersey, Delaware, the District of Columbia, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, Tennessee, Kentucky, Mississippi, Arkansas, Louisiana, Texas, New Mexico, Arizona, Nevada, California, Oregon, and Washington the open season shall be from November 16 to December 15;

In Florida the open season shall be from November 20 to December 19; and

In Alaska the open season shall be from September 1 to September 30.

Wilson's snipe or jacksnipe.—The open season for Wilson's snipe or jacksnipe shall be as follows:

In Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York (except Long Island), Pennsylvania, West Virginia, Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Nebraska, South Dakota, North Dakota, Montana, Wyoming, Colorado, Utah, Idaho, Nevada, California, Oregon, and Washington, the open season shall be from October 1 to December 31;

In that portion of New York known as Long Island, and in New Jersey, Delaware, Oklahoma, New Mexico, Arizona, and in that portion of Texas lying west and north of a line beginning on the Rio Grande River directly west of the town of Del Rio, Tex.; thence east to the town of Del Rio; thence easterly following the center of the main track of the Southern Pacific Railroad through the towns of Spofford, Uvalde, and Hondo; thence to the point where the Southern Pacific Railroad crosses the International & Great Northern Railroad, at or near San Antonio; thence following the center of the track of said International & Great Northern Railroad in an easterly direction, to the point in the city of Austin, where it joins Congress Avenue, near the International & Great Northern Railroad depot; thence across Congress Avenue to the center of the main track of the Houston & Texas Central Railroad where said track joins said Congress Avenue, at or near the Houston & Texas Central Railroad depot; thence following the center line of the track of said Houston & Texas Central Railroad in an easterly direction through the towns of Elgin, Giddings, and Brenham, to the point where said railroad crosses the Brazos River; thence with the center of said Brazos River in a general northerly direction, to the point on said river where the Beaumont branch of the Gulf, Colorado & Santa Fe Railway crosses the same; thence with the center of the track of the said Gulf, Colorado & Santa Fe Railway in an easterly direction through the towns of Navasota, Montgomery, and Conroe, to the point at or near Cleveland, where said Gulf, Colorado & Santa Fe Railway crosses the Houston East & West Texas Railway; thence with the center of said Houston East & West Texas Railway track to the point in said line, where it strikes the Louisiana line *the open season shall be from October 16 to January 15;*

In that portion of Texas lying south and east of the line above described the open season shall be from November 1 to January 15;

In Maryland, the District of Columbia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Arkansas, and Louisiana the open season shall be from November 1 to January 15.

In Florida the open season shall be from November 20 to January 15; and

In Alaska the open season shall be from September 1 to December 15.

Rails and gallinules (except coot).—The open season for sora and other rails and gallinules (except coot) shall be from September 1 to November 30, except as follows:

In Massachusetts the open season shall be from October 1 to December 15;

In New York and Washington the open season shall be from October 1 to November 30; and

In Louisiana the open season shall be from November 1 to January 31.

Woodcock.—The open seasons for woodcock shall be as follows:

In that portion of New York lying north of the tracks of the main line of the New York Central Railroad extending from Buffalo to Albany and north of the tracks of the main line of the Boston & Albany Railroad extending from Albany to the Massachusetts State line, and in Maine, New Hampshire, Vermont, and North Dakota the open season shall be from October 1 to October 31;

In that portion of New York lying south of the line above described including Long Island and in New Jersey, Pennsylvania, Ohio, Indiana, Michigan, Wisconsin, and Iowa the open season shall be from October 15 to November 14;

In Massachusetts, Rhode Island, and Connecticut the open season shall be from October 20 to November 19;

In Maryland, the District of Columbia, and Missouri the open season shall be from November 10 to December 10;

In Delaware, Virginia, West Virginia, Kentucky, Arkansas, and Oklahoma the open season shall be from November 15 to December 15; and

In North Carolina, South Carolina, Georgia, Alabama, Mississippi, and Louisiana the open season shall be from December 1 to December 31.

Doves.—The open seasons for mourning doves shall be as follows:

In Delaware, Maryland, Virginia, Tennessee, Kentucky, Illinois, Minnesota, Nebraska, Kansas, Missouri, Arkansas, Oklahoma, New Mexico, Utah, Arizona, California, Nevada, Idaho, and Oregon the open season shall be from September 1 to December 15.

In that portion of Texas lying west and north of the zone line described above under "Wilson's snipe or jacksnipe," the open season shall be from September 1 to October 31; and in that portion of Texas lying south and east of the line above described the season shall be from October 1 to November 30;

In North Carolina, South Carolina, Georgia, Alabama (except in Mobile and Baldwin Counties), Mississippi, and Louisiana the open season shall be from September 1 to September 30 and from November 20 to January 31;

In that portion of Alabama comprising Mobile and Baldwin Counties the open season shall be from November 1 to January 31;

In Florida (except in Dade, Monroe, and Broward Counties) the open season shall be from November 20 to January 31.

In that portion of Florida comprising Dade, Monroe, and Broward Counties the open season shall be from September 16 to November 15.

BAG LIMITS AND OTHER PROVISIONS UNDER FEDERAL REGULATIONS

Bag and possession limits.—A person may take in any one day during the open seasons prescribed therefor not to exceed the following numbers of migratory game birds, which numbers shall include all birds taken by any other person who for hire accompanies or assists him in taking migratory birds; and in the case of ducks and geese when so taken these may be possessed in the numbers specified as follows:

Ducks (except wood duck and eider ducks), 15 in the aggregate of all kinds, 30 in possession.
Geese, including brant, 4 in the aggregate of all kinds, 8 in possession.
Coots, 25.
Sora, 25.
Rails and gallinules (except sora and coots), 25 in the aggregate of all kinds, but not more than 15 of any one species.
Wilson's snipe, or jacksnipe, 20.
Woodcock, 4.
Mourning doves, 25.

No other migratory birds may be taken at any time except under permit for propagating, scientific, or banding purposes, or under an order of the Secretary of Agriculture to prevent injury to agricultural or other interests.

Time of day and methods.—Migratory game birds may be taken from the land and water on any day during the open season from half an hour before sunrise to sunset, except that the hour for the commencement of shooting on the opening day of the season shall be 12 o'clock noon. They may be taken with a gun only, not larger than No. 10 gauge, fired from the shoulder, with the aid of a dog, the use of decoys, and from a blind or floating device, except that in the hunting of wild geese not more than ten (10) live goose decoys may be used or shot over at any one gunning stand, blind, or floating device; but nothing herein shall be deemed to permit the use of an automobile, airplane, powerboat, sailboat, any boat under sail, any floating device towed by powerboat or sailboat, or any sinkbox (battery), except that sinkboxes (batteries) may be used in the taking of migratory waterfowl in coastal sounds and bays (including Back Bay, Princess Anne County, State of Virginia) and other coastal waters; and nothing herein shall be deemed to permit the use of an airplane, or a powerboat, sailboat, or other floating device for the purpose of concentrating, driving, rallying, or stirring up migratory waterfowl, provided, however, that the hunting, killing, or taking of mourning doves is not permitted on or over, at or near, any area which has been baited with salt, corn, wheat, or other grain or other foods placed or scattered thereon.

Possession.—Migratory game birds legally taken may be possessed during the period constituting the open season where killed and for an additional period of 10 days next succeeding such open season, and those coming from a country other than Canada may be possessed in the State into which they are brought only during the open season in that State and such additional time immediately thereafter as may be permitted by both Federal and State laws.

Interstate traffic in game.—Not more than two days' bag limit of migratory game birds, as prescribed by the Federal regulations, may be exported or removed from the State where taken in any one calendar week, and such migratory game birds or parts thereof in transit during the open season may continue in transit such additional time, not exceeding five days, as may be necessary for delivery at destination.

The Lacey Act prohibits interstate shipment by common carrier of wild animals or parts thereof where such animals have been killed or shipped in violation of the laws of the State in which killed or from which shipped, and section 4 of the treaty act likewise prohibits the removal in any manner from one State to another of any wild birds in violation of State laws or which have been illegally taken. All packages in interstate commerce containing game animals or nonmigratory game birds, or parts thereof, must be marked to show the names and addresses of the consignor and consignee and the nature of the contents, and packages containing migratory birds must be marked with such addresses and the number and kind of such birds therein.

Sale.—The Federal law prohibits the sale of all migratory birds throughout the United States except birds taken for scientific or propagating purposes and waterfowl raised on farms or preserves under permit from the Secretary of Agriculture.[2] Feathers of wild ducks and wild geese lawfully killed, and of such birds seized and condemned by Federal or State authorities, may be purchased and sold for use in the manufacture of fishing flies, pillows, and mattresses, but not for millinery or ornamental purposes.

Alaskan exceptions.—In Alaska, Eskimos and Indians may take for the use of themselves and their immediate families, in any manner and at any time, and possess and transport auks, auklets, guillemots, murres, and puffins and their eggs for food and their skins for clothing.

Permits for propagation and other purposes.—Under appropriate permit from the Secretary of Agriculture, and when allowed by State law, migratory water fowl may be captured at any time for propagating purposes, and waterfowl bred in captivity may be killed and the carcasses sold and used for food puposes. Waterfowl captured and bred in captivity may also be sold alive for breeding and exhibition purposes to the holders of permits. Under appropriate permit all species of migratory birds, except whooping cranes, trumpeter swans, and Eskimo curlew, may be taken for scientific purposes, and all species may be taken for banding. The Secretary of Agriculture may also issue orders permitting the killing of migratory birds to prevent serious injury to agriculture or other interests.

Further restrictions by States.—The States may shorten the open seasons fixed by Federal regulations on migratory birds, reduce the bag limits, prohibit export, restrict the period during which migratory birds may be possessed in closed season, or make other laws or regulations to give further protection to such birds, but may not lengthen the open season, increase the bag limit, permit sale or otherwise lessen the protection afforded by Federal law.

---

[2] See footnote 1, p. 8.

SUMMARY OF LAWS RELATING TO SEASONS, LICENSES, LIMITS, POSSESSION, TRANSPORTATION, AND SALE

Game laws and information.—Persons are advised to obtain from State game commissioners the full text of game laws in States where hunting is contemplated. (See list on p. II, on back of title-page.) They should also obtain information from the Bureau of Biological Survey or State game departments[3] regarding the existence of Federal and State game and bird refuges in areas in which they contemplate hunting, as the location of refuges and the restrictions regarding hunting thereon are not included in this bulletin.

Open season dates.—The dates of open seasons for migratory game birds shown under the various States and Provinces are the times when these birds may be hunted without violating either State or Provincial laws or Federal or Canadian regulations.

In stating the open season[4] the plan has been followed of including the first and last days thereof. The difficulty of attaining absolute accuracy in a statement of the seasons is great, but summaries have been submitted to the proper State or provincial game officials for correction and approval, and the dates as stated are believed to be free from material errors.

Permanent close seasons.—Species (including migratory game[5] and nongame[5] birds—but not migratory insectivorous[5] birds—protected throughout each year by Federal regulations) on which the season is closed for a term of years or for an indefinite period are grouped under the term "No open season." Provisions of State laws prohibiting hunting at night, between sunset and sunrise, or during certain hours are not included.

Rest days.—In some States certain days of the week constitute rest days or close seasons during the time when hunting is permitted. Hunting on Sunday is prohibited in all States and Provinces east of the one-hundred and fifth meridian, except Illinois, Louisiana, Michigan, Rhode Island, South Dakota, Texas, Wisconsin, and Quebec. Mondays constitute a close season for waterfowl locally in California and North Carolina; Wednesdays for ducks and coot in Wisconsin; Wednesdays and Thursdays east of Blue Ridge Mountains in Virginia; and certain other week days for waterfowl in several favorite ducking grounds in California, Maryland, North Carolina, and Florida. In Oregon mountain and valley quail, Hungarian partridges, and Chinese pheasants may be hunted locally only on Wednesday and Sunday of each week during the open season. In Oklahoma quail may be hunted only on Monday, Wednesday, and Friday of each week during the open season, and on Thanksgiving Day and Christmas and New Year's Day, or the preceding Saturdays, if these fall on Sundays. Hunting is prohibited when snow is on the ground in New Jersey, Delaware, and Virginia, locally on all game except waterfowl in Maryland, and in North Carolina, except for deer, bear, and waterfowl.

Possession.—The provision of the Federal regulations permitting the possession of migratory game birds during the first 10 days of the close season has been considered in connection with State laws, and when migratory game birds may be possessed during any part of the close season without violating either the Federal regulations or State laws it has been stated under the heading "Bag limits and possession."

Possession of nonmigratory game during the close season is generally prohibited by State laws, but when an extension of a few days, or a special season, is provided for either possession or sale, attention is called thereto.

Interstate transportation.—Under the heading "Interstate transportation," in addition to statements of restrictions on removal of game from the State in which it is taken, information has been included concerning the importation and possession by sportsmen for personal use of game legally killed outside the State and legally exported from the place where taken. In the absence of specific State legislation to the contrary, or where legislation prohibits possession of game in close season, it has been construed that sportsmen may bring home their game and possess it in their State in the same manner as if it had been killed there.

Propagated and imported game.—For laws concerning traffic in imported game and game raised in captivity under Federal and State licenses, see pages 43 to 45.

---

[3] See list on page II (back of title-page). A full list of names and addresses of officials and organizations concerned with wild-life protection will be found in Miscellaneous Publication No. 122, U. S. Department of Agriculture, 1931.

[4] For open seasons on fur-bearing animals for 1931–32 see Farmers' Bulletin No. 1685.

[5] For definitions, see p. 8.

STATE LAWS

ALABAMA

Open seasons:[6]	*Dates inclusive*
Deer (male)	Nov. 1-Dec. 31.
Bear	Nov. 1-Feb. 28.
Squirrel (black, gray, fox)	Nov. 1-Jan. 31.[7]
Quail (partridge)	Nov. 20-Feb. 20.
Wild turkey gobbler	Dec. 1-Dec. 31. Mar. 1-Apr. 10.
Duck, goose (except Ross's goose and cackling goose), brant, coot (mud hen)	Nov.16-Dec.15.[6] [8]
Woodcock	Dec. 1-Dec. 31.[6]
Wilson's snipe or jacksnipe	Nov. 1-Jan. 15.[6]
Rail and gallinule, other than coot	Sept. 1-Nov. 30.[6]
Turtle dove (see exception)	Sept. 1-Sept. 30. Nov. 20-Jan. 31.
Exception: In Mobile and Baldwin Counties	Nov. 1-Jan. 31.

No open season: Ruffed grouse (pheasant), introduced pheasants, or other introduced game bird (1931); does, turkey hens, swans, Ross's and cackling geese, wood duck, bitterns, sand-hill and whooping cranes, grebes, gulls, herons, loons, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident or alien, game, $25; fish, $5. Resident: Game, State $3; county, $1. Trapping (bears and other furbearing animals), $15 for first trap and $2.50 for each additional trap. Issued by probate judges. Landlords and members of families may hunt or trap on own land during open season without license. Written permission required for hunting or trapping on land of another.

Bag limits and possession: One buck a day or in possession, 5 a season; 1 turkey gobbler a day or in possession, 10 a season; 10 squirrels a day or in possession; 15 quails a day or in possession; 4 geese, including brant, a day, 8 in possession; 20 Wilson's snipe a day, 25 in possession; 15 ducks a day, 30 in possession; 25 each of doves, coots, and sora a day or in possession; 25 in all of rails (except sora) and gallinules a day, but not more than 15 of any one species, 25 each in possession; 4 woodcock a day, 25 in possession. Possession of migratory game birds permitted during first 10 days of close season; other game during first 5 days.

Interstate transportation: Export of all protected game prohibited, except that a nonresident licensee may take with him, openly, game he has lawfully killed, but not more than two days' limit of migratory birds may be exported in any one calendar week.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of all protected game prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live-goose decoys at any one stand or blind in the hunting of wild geese. Doves may not be shot on, at, or near any area on which salt, grain, or other food has been scattered to attract them.

ALASKA

Open seasons:[9]	*Dates inclusive*
Bull moose (except yearlings and calves)	Sept. 1-Dec. 31.[10]
Caribou, south of Yukon River	Aug. 20-Dec. 31.[11]
North of Yukon River	No close season.
Deer (male, with horns not less than 3 inches above skull), east of longitude 138° (southeastern Alaska)	Aug. 20-Nov. 15.
In rest of Territory	No open season.
Mountain sheep (rams), mountain goats (except kids)	Aug. 20-Dec. 31.[10]
Bear (large brown and grizzly)	Sept. 1-June 20.[12]
Black bear, polar bear (fur animals)	No close season.
Grouse, ptarmigan	Sept. 1-Feb. 28.
Duck, goose (except Ross's goose and cackling goose), brant	Sept. 1-Sept. 30.[13]
Wilson's snipe, or jacksnipe	Sept. 1-Dec. 15.[13]

No open season: Buffalo; elk; calf, yearling, and cow moose; fawns and doe deer; mountain-sheep lambs and ewes; mountain-goat kids; swans, Ross's and cackling geese, eider ducks, rails, coot, cranes, auklets, fulmars, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting licenses: Nonresident citizen: General, $50; small game, $10; nonresident big-game hunter must be accompanied by registered guide except in fur district 8; licenses issued by commissioners, wardens, and special agents. Resident, $2 (trapping license required for taking black bears, which are fur animals under the law; not required of native-born Indians, Eskimos, or half-breeds who have not exercised the right of franchise or severed their tribal relations). Alien, $100 (special license required to hunt or possess firearms); issued by commission. Licensed hunters and trappers, within 30 days after expiration of license, must report to commission number and kind of each species of birds or animals taken.

---

[6] *Alabama:* Hunting prohibited on all State lands. Season on migratory game birds opens at 12 o'clock noon.

[7] Squirrels may be killed at any time on own premises when destroying property.

[8] Monday and Tuesday are rest days for ducks, geese and coot in Mobile County, and part of Baldwin County.

[9] *Alaska:* All hunting is prohibited in Mount McKinley National Park, Katmai and Glacier Bay National Monuments, Kruzof and Partofshikof Islands, in Eyak Lake closed area, and in Keystone Canyon closed area, including half a mile on each side of Richardson Highway from mile post 13 to mile post 20 from Valdez to Snowslide Gulch, and Curry and Alaska Railroad closed areas; and, except under permit of the Secretary of Agriculture, in Aleutian Islands Reservation (including Unimak Island) and other national bird and mammal reservations. An Indian, Eskimo, or half-breed who has not severed his tribal relations, and an explorer, prospector, or traveler may take mammals or birds other than migratory birds (except Eskimos and Indians may take auks, auklets, guillemots, and puffins, and their eggs) in any part of Territory at any time for food when in absolute need of food and other food is not available, but he shall not ship or sell any mammal or bird or part thereof so taken.

[10] Unlawful to hunt moose on Alaska Peninsula south and west of Kvichak River, Iliamna Lake, and portage from Kamishak Bay to Kakhonak Bay; and mountain sheep or mountain goats on Kenai Peninsula east of longitude 150° (5 miles east of Stalter place on Kenai River); and mountain goats on Baranof or Chichagof Islands.

[11] Unlawful to hunt caribou in Steese Highway closed areas, including half a mile on each side of highway at Twelve Mile Summit and Eagle Summit.

[12] Season on large brown and grizzly bears applies throughout Territory to nonresidents. No closed season to residents except (1) in drainage to Gulf of Alaska from west shore of Glacier Bay to Alsek River, (2) drainage to Gulf of Alaska from west shore of Yakutat Bay and west edge of Hubbard Glacier to Bering River, (3) drainage to west side of Cook Inlet between west bank of Susitna River to its confluence with Yentna River, thence along west bank of Yentna River to its confluence with Skwentna River, thence along south bank of Skwentna River to summit of Alaska Range and the old portage from Kakhonak Bay on Iliamna Lake to Kamishak Bay, (4) all of Alaska Peninsula south and west of Kvichak River, Iliamna Lake, and old portage from Kakhonak Bay to Kamishak Bay, (5) and the following islands: Hawkins, Hinchinbrook, Montague, Yacobi, and Shuyak, where the open season to residents is September 1 to June 20; and in areas named a resident may kill a large brown or grizzly bear at any time or place when such animal is about to attack or molest persons or property.

[13] Season on migratory game birds opens at 12 o'clock noon.

Guide, $10 (issued only to resident citizens or resident native Indian or Eskimo); issued by commission. Guide must report to commission after each hunting trip.

Shipping licenses: Resident (export for mounting and return), $1 for each trophy; resident removing from Territory, $1 for each trophy; if otherwise, $5 for each animal, $1 for each bird. Issued by commission or collector of customs.

Bag limits and possession: Caribou, nonresident 2, resident 5, a season (except on Alaska Peninsula, resident 2, nonresident 1); mountain sheep, nonresident 2, resident 3, a season, of which not more than 2 may be taken south of Arctic Circle; 1 moose, 3 deer, 2 mountain goats a season or in possession; 2 in all of large brown and grizzly bears a season or in possession (nonresident); no limit for resident except 2 only in certain areas where a season is prescribed for residents. Game animals legally taken during open season may be possessed and transported within Territory by any person at any time. Number of game animals in excess of season limit may be possessed under permit of commission; 15 grouse, 25 ptarmigan, but not more than 25 in all of grouse and ptarmigan a day; 15 ducks, 4 geese, including brant, a day; 20 Wilson's snipe a day. Migratory game birds legally taken may be possessed during open season and 10 days thereafter, but not more than 50 in all of waterfowl may be possessed at one time of which not more than 30 may be ducks, and 8 geese, including brant. Game animals, grouse, ptarmigan, hides, heads, and feet of game animals or articles made therefrom and skins and feathers of game birds legally taken during open season may be possessed and transported at any time within the Territory, and shed antlers of deer, moose, or caribou may be possessed and transported within or out of the Territory at any time without a license.

Interstate transportation: Nonresident citizen or nonresident alien licensee may export 1 moose, 3 deer, 2 caribou (1 from Alaska Peninsula), 2 mountain sheep, 2 mountain goats, and 2 in all of large brown and grizzly bears killed by himself under license coupon and affidavit that he has not violated the game laws; that big-game animal or part thereof he desires to ship has not been purchased or sold and is not shipped for purpose of being sold; that he lawfully killed the animal and is owner of part thereof that he desires to ship, and if shipment contains caribou or parts thereof, whether animal was killed on Alaska Peninsula.

A nonresident may possess and transport at any time within or out of Territory skins and feathers of game birds and articles manufactured from hides or hoofs of moose, caribou, deer, or goats legally taken. Any person may without a license export shed antlers of moose, caribou, or deer.

Resident may export for mounting and return in any one year, but not for sale, heads or trophies of game animal legally acquired under shipping license (fee, $1 for each trophy).

A resident who is removing his residence from Territory may export trophies of game animals legally acquired by him under shipping license (fee, $1 for each trophy).

All shipments must be marked with names and addresses of consignor and consignee and number of each kind of game contained therein.

Sale: Sale of all protected game prohibited, except that meat of caribou may be sold by the person killing it, but such meat may not be resold north of summit Alaska Range-Ahklun Mountains except in cooked form, nor south of said summit except in cooked form and then only at road houses having permits from the commission; moose, grouse, and ptarmigan legally killed may be bought and sold at any time north of summit of Alaska Range and Ahklun Mountains, but no person other than the one who killed them may sell them except in cooked form for human food, but meat of moose, grouse, or ptarmigan may not be sold or served by restaurants, road houses, or public or other eating houses located within 5 miles each side of the center line of Alaska Railroad and its branches; number of animals in excess of season limit allowed in possession under permit of commission. Meat of mammals or birds so sold shall not be transported to or possessed in any other part of Territory. No game animal, game bird, or parts thereof shall be sold to or bought by the owner, master, or employee of any coastal or river steamer or commercial power or sail boat; unlawful to take or possess for serving or to serve any game animal, game bird, or part thereof in any dining car, commercial mess house operated by a cannery, railroad, or contractor, or in any other commercial mess house or other place maintained for serving food regularly to employees thereof, or to serve such game to an employee of any coastal or river steamer or commercial power or sail boat, or for an employee of a railroad, cannery, contractor, or coastal or river steamer or other commercial power or sail boat to possess such game in a dining car or commercial mess house, or in the galley or dining room of any such boat.

Any person may without a license buy and sell at any time in Territory feathers of wild ducks and geese, lawfully killed or seized and condemned by Federal game authorities, for use in making fishing flies, bed pillows, mattresses, and similar commercial purposes, but not for millinery or ornamental purposes; hides or parts of hides of moose, caribou, deer, and mountain goats legally taken during the open season; shed antlers of caribou, moose, and deer; and skins and feathers of eagles, crows, hawks, owls, ravens, and cormorants.

ARIZONA

Open seasons:[14]	*Dates inclusive*
Deer (male with pronged horn), bear, wild turkey (see exception)	Oct. 16–Nov. 15.
Exception: Black-tailed or mule deer, bear, turkey, south of Gila River	No open season.
Peccary or javelina	Nov. 1–Jan. 31.
Squirrel (see exceptions)	Oct. 16–Nov. 15.
Exceptions: Kaibab squirrels in State, and Chiricahua and Arizona tree squirrels south of Gila and Salt River base meridian	No open season.
Quail (Gambel's, scaled) (see exception)	Nov. 1–Dec. 31.
Exception: In Apache and Navajo Counties	No open season.
White-winged dove	July 15–Aug. 31.
Mourning Dove	Sept. 1–Dec. 15.[15]
Duck, goose (except Ross's goose and cackling goose) brant	Nov. 16–Dec. 15.[15]
Wilson's snipe	Oct. 16–Nov. 30.[15]
Coot	Nov. 16–Nov. 30.[15]

No open season: Does, spotted fawns, spike bucks, elk, antelope, mountain sheep, bobwhite and Mearns's quail, grouse, pheasant, swans, Ross's and cackling geese, bitterns, little brown and sandhill cranes, grebes, gulls, herons, loons, band-tailed pigeons, terns, rails, gallinules, and all shore birds except Wilson's snipe or jacksnipe.

Hunting and fishing licenses: Nonresident: Game and fish, $35; small game and fish, $10; special 15-day fishing, $2.50. Resident: Game and fish, $2.50; fish, $1.25. Alien: Game and fish, $75; small game and fish, $30. Special license, alien applicant for citizenship, game, $25; alien applicant for citizenship, small game and fish, $10. Guide, $10. American-born resident or nonresident under 16 years of age may hunt and fish without license if accompanied by holder of a valid license.

Bag limits and possession: One deer, 1 bear, 1 peccary or javelina, 6 squirrels, 2 turkeys a season; 15 quail a day or in possession; 15 ducks a day or in possession; 2 geese, 2 brant a day or in possession; 15 in all of Wilson's snipe and coots a day or in possession; 20 doves. One male deer, 2 wild turkeys, or one day's bag limit of other game lawfully taken may be possessed for 10 days after close of season.

---

[14] *Arizona:* Animals or birds (except migratory birds) that become seriously injurious to agriculture or other interests may be killed under permit of commission.

[15] Season on migratory game birds opens at 12 o'clock noon.

Interstate transportation: Nonresident licensee may ship one day's bag limit of game or fish a week under permit attached to his license, and may procure additional license for additional shipment. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of all protected game prohibited.

Miscellaneous: Use of dog in taking game animals, except bear, prohibited.

Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been scattered for attracting them.

ARKANSAS

Open seasons:	*Dates inclusive*
Male deer (with horns plainly visible above skull), turkey gobblers (gobblers also Apr. 1–Apr. 30)	Nov. 9–Nov. 14. Dec. 20–Jan. 1.
Squirrel (see exceptions)	July 1–Jan. 1.
Exceptions: In Ashley, Chicot, Desha, Drew, Lincoln, and Nevada Counties	May 15–June 15. Oct. 1–Jan. 1.
In Calhoun, Clark, Cleveland, Columbia, Dallas, Garland, Grant, Little River, Ouachita, and Union Counties	Oct. 1–Jan. 1.
In Phillips and Yell Counties	May 15–June 15. Sept. 1–Jan. 1.
In Van Buren County	May 10–Jan. 1.
In Crawford County	May 20–Jan. 1.
In Arkansas County	June 1–Nov. 1.
In Bradley County	June 1–Jan. 1.
In Franklin County	Apr. 15–Dec. 31.
In Montgomery County	May 15–June 15. Sept. 1–Nov. 7. Nov. 16–Dec. 28.
In Baxter, Boone, Carroll, Fulton, Izard, Logan, Madison, Marion, Newton, Searcy, and Sharp Counties	No close season.
Grouse	Dec. 16–Jan. 15.
Pheasant, prairie chicken	Dec. 1–Dec. 15.
Quail or partridge (bobwhite)	Dec. 1–Jan. 31.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Nov. 16–Dec. 15.[16]
Wilson's snipe or jacksnipe	Nov. 1–Jan. 15.[16]
Woodcock	Nov. 15–Dec. 15.[16]
Dove	Sept. 1–Dec. 15.[16]
Gallinule	Nov. 1–Nov. 30.[16]
Rail, other than coot and gallinule	Sept. 1–Nov. 30.[16]

No open season: Does, fawns, and wild-turkey hens; bears, Ross's and cackling geese, swans, wood ducks, bitterns, sand-hill and whooping cranes, grebes, gulls, herons, loons, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game, $15; fish, general, $5; special 15-day (trip), $1.10; resident: Game, $1.10; fish, $1.10. For dog in hunting, $1.50. Issued by State game and fish commission and circuit clerks. Resident hunting license not required of person under 18 years of age. License not required of residents for hunting rabbits, squirrels, or predatory birds and animals or of a person hunting on his own premises. Hunting prohibited on inclosed lands without consent of owner.

County licenses.—Chicot County: Nonresident of State, $50; resident of State: All game, $5.25; game (except deer and turkey), $2.25. Dog (for deer or quail hunting), $1.10. *Desha County:* Nonresident of State, $50; resident of State: All game, $2.50; game (except deer and turkey), $1.10. Dog (for deer or quail hunting), $1. License not required of resident under 16 in Chicot and Desha Counties.

Bag limits and possession: Two deer, 2 turkeys a season, 8 squirrels, 3 pheasants, 3 prairie chickens, 12 quail, 25 doves, 15 ducks, 4 geese, including brant, 4 woodcock, 12 Wilson's snipe, 15 in all of rails, coots, and gallinules, a day or in possession. Two days' limit of squirrels, quail, or ducks may be possessed at one time, except while in the field hunting or while returning from a hunt of one day's duration. Possession of migratory game birds permitted during first 10 days of close season.

Interstate transportation: Export of all game prohibited; provided a nonresident, under each of 3 tags attached to his license may ship out 1 days' limit of game; and he may carry out at one time not more than 1 day's limit, but not moore than 2 days' limit may be removed from State in any one calendar week; specimen of game may be exported by any person under permit to be mounted, tanned, or made into wearing apparel.

Game taken outside of State and legally exported may be possessed in State at any time.

Sale: Sale of all protected game prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese. Doves may not be shot on, at, or near any area on which salt, grain, or other food has been scattered to attract them.

CALIFORNIA [17]

Open seasons:	*Dates inclusive*
Male deer (except spike bucks):	
In districts 1, 4, 4½, 4¾, 23, 24, and 25	Sept. 16–Oct. 15.
In district 1½	Sept. 1–Oct. 15.
In district 1¾ (deer must have more than two branches to each antler	Sept. 16–Oct. 15.
In districts 2, 2½, and 3	Aug. 1–Sept. 14.

---

[16] Season on migratory game birds opens at 12 o'clock noon.

[17] *California:* Of the 72 fish and game districts created under the act of 1917, as amended in 1929, 9 (1, 1½, 1¾, 2, 2½, 3, 4, 4½, and 4¾) are properly hunting districts, 14, 15, 23, 24, and 25, are fishing districts but are open to hunting; of the other 58 districts, 36 are game refuges, 1 a fish reservation, and 21 are commercial fishing districts.

District 1 comprises the eastern half of the Sacramento and San Joaquin Valleys, including all counties not included in districts 1½, 1¾, 2, 2½, 3, 4, 4½, and 4¾.

District 1½ comprises the counties of Del Norte and Humboldt, and that part of Siskiyou west of Pacific Highway and Weed-Klamath Falls Highway.

District 1¾ comprises Modoc and Lassen Counties and Siskiyou County east of Southern Pacific Railroad and Klamath River.

District 2 comprises that part of State south of Humboldt and Tehama Counties, west of Sacramento River and north of San Francisco Bay, including counties of Glenn, Colusa, Yolo, Solano, Napa, Lake, Sonoma, and Marin, and that portion of Mendocino County not included in district 2½.

District 2½ comprises townships in Mendocino County bordering on Pacific Ocean (except township 11 north, ranges 15 and 16 west) and townships 13, 14, 15, 16, 17, and 18 north, range 16 west.

District 3 comprises region around southern portion of San Francisco Bay and coast counties south of the Golden Gate as far as Ventura, including counties of Contra Costa, Alameda, San Mateo, Santa Clara, San Francisco, Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, and Ventura; also San Benito and western half of San Joaquin, Stanislaus, Merced, Fresno, Kings, and Kern Counties.

District 4 comprises counties in southern California, namely, Los Angeles, Orange, Riverside, and San Bernardino.

District 4½ comprises counties of Mono and Inyo.

District 4¾ comprises San Diego and Imperial Counties.

Footnote continued on p. 16, col. 1.

Open seasons—Continued.	*Dates inclusive*
Bear (black, brown) (see exception)	Nov. 15–Feb. 28.
Exception: In districts 2 and 2½	No close season.
Cottontail and brush rabbits,[18] (see exception)	Nov. 15–Dec. 15.
Exception: Rabbits in district 4¾	No close season.
Quail (see exception)	Nov. 15–Dec. 15.
Exception: In district 1½	Nov. 1–Dec. 31.
Dove (see exception)	Sept. 1–Sept. 30.[19]
Exception: In districts 4, 4½, and 4¾	Sept. 1–Oct. 31.[19]
Duck, goose (except Ross's goose and cackling goose) brant, coot (mud hen)	Nov. 16–Dec. 15.[19]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[19]
Gallinule	Oct. 1–Nov. 30.[19]

No open season: Does, spike bucks, fawns, elk, antelope, mountain sheep; tree squirrels; sierra hares; pheasants, introduced quail or partridges, sage hen, grouse, turkeys, rail, plovers, yellowlegs, swans, Ross's and cackling geese, wood duck, eider ducks, auklets, bittern, little brown, sand-hill, and whooping cranes, fulmars, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, band-tailed pigeons, puffins, shearwaters, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Game: Nonresident, $10; alien, $25 (except those with first papers, fee $10); fish: Nonresident, $3; alien, $5; resident: Game, $2 (resident, under 18, $1); fish, $2. Fishing license not required of persons under 18 years of age. To veterans of the Civil War, issued free of charge. Issued by commissioners and county clerks. Unlawful to hunt on posted lands of another without permission of owner. Deer-tag license, $1; commercial club, citizen owner, $25; alien owner, $100; citizen operator, $5; alien operator, $25.

Bag limits and possession: Two deer a season (except in district 1¾, one only); 15 cottontail or brush rabbits a day, 30 a week; 10 mountain quail a day, 20 a week; 15 valley or desert quail a day, 30 a week; 20 Wilson's snipe or jacksnipe a day, 50 a week; 15 mourning doves a day, 30 a week; 15 ducks a day; 4 geese (honkers) including brant, a day, 24 a week; 25 coots (mud hens), but not more than 15 gallinules a day, 50 mud hens a week.

Possession in excess of daily limit prohibited, except that not more than 25 wild ducks and 8 wild geese, including brant, may be possessed at any one time. Persons killing deer must retain in possession during open season and 10 days thereafter skin and portion of head bearing horns. One day's limit of game birds or animals may be possessed during first 5 days of close season.

Interstate transportation: Export of all protected game prohibited. All shipment by parcel post prohibited.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of deer meat and hides, tree squirrels, and game birds prohibited. Hides of deer taken in a foreign country and cottontail and brush rabbits taken during open season may be sold.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been scattered to attract them.

COLORADO

Open seasons:[20]	*Dates inclusive*
Deer (having horns with two or more prongs on each horn)	Oct. 12–Oct. 15.
Elk	Nov. 5–Nov. 10.
Rabbit, hare	No close season.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 1–Oct. 31.[21]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[21]
Sora and other rails and gallinule (except coot)	Sept. 1–Nov. 30.[21]

No open season: Antelope, mountain sheep, does, fawns, Abert's, black or tuft-eared squirrels, prairie chickens, mountain and willow grouse, sage chickens (1932), quail (bobwhite and crested), pheasants,[22] doves; partridges, ptarmigan, wild turkeys, swans, Ross's and cackling geese, wood duck, eider ducks, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, band-tailed pigeons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Big game, $25; small game, $5; fish, $3. Resident: Big game, $5; small game and fish, $2. Special elk license: Nonresident, $50; resident, $7.50. Not issued to persons under 21. Holder of big-game license only pays difference in cost of big game and elk license. No person under 18 is permitted to hunt big game. Fishing license not required of boys under 16 or of women. Children under 12 not permitted to hunt except on own premises or those of parent or guardian. Guide, $5, in addition to hunting license. Issued by commissioner, county clerks, and other agents. Unlawful to hunt in any inclosure not public land without consent of owner. Unlawful to shoot game from public highway.

Unnaturalized foreign-born residents not permitted to hunt or to own or possess shotgun, rifle, or pistol.

Bag limits and possession: One deer a season, coupon required; 15 ducks, 4 geese, including brant, 15 Wilson's snipe, 25 sora, 15 in all of other rails, coots, and gallinules a day or in possession, except that not more than 25 ducks and 8 geese, including brant, may be possessed at any one time. Persons under 12 years of age limited to half this number of birds. Possession permitted during first 5 days of close season. Commissioner may issue permit authorizing storage, possession, and use of game for 90 days after close of open season (except possession of migratory birds limited to 10 days after close of season).

Interstate transportation: Export of all protected game is prohibited; provided, game in not exceeding the numbers allowed in possession, may be exported under permit from game commissioner (fee, 25 cents for each bird) if permit be attached and packages plainly marked so as to show nature of contents, but not more than two days' limit of migratory birds shall be exported in any one calendar week; edible portion of deer may be exported under $5 permit from the commissioner.

Game taken outside of State and legally exported may be possessed at any time, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season. Importer must obtain from State game and fish commissioner a certificate, fee $1, to import game.

---

[17] Footnote continued.

Districts 23, 24, and 25, all located in district 1, are as follows:

District 23 comprises drainage area of Lake Tahoe and Truckee River and head waters of Rubicon and American Rivers, in counties of Placer and Eldorado.

District 24 comprises drainage area of Silver, Twin, Blue, Meadow, and Wood Lakes in counties of Alpine and Amador and the watershed of the upper Consumes River.

District 25 comprises drainage area of Lake Almanor in counties of Plumas and Lassen.

[18] Owner or tenant, or person holding written permission from owner or tenant, may kill rabbits on own premises at any time, but rabbits killed in close season may not be shipped or sold.

[19] Season on migratory game birds opens at 12 o'clock noon. Waterfowl in districts 4, 4¾, 4a, 4e, 19, 20, 20a, and 22 may be hunted only on Wednesdays, Saturdays, Sundays, legal holidays, and opening and closing days of season, and in district 4a waterfowl may not be hunted on said days before 8 a. m.

[20] *Colorado:* Game and fish commissioner, on petition of board of county commissioners, may suspend or shorten seasons on game in any county or under justifiable conditions may lengthen them.

[21] Season on migratory game birds opens at 12 o'clock noon.

[22] Pheasants damaging crops may be killed or trapped under permit of commissioner.

Sale: Sale of all game taken in State prohibited, but game (except migratory birds) coming from without State may be sold under importer's license by indorsement of shipping invoice to purchaser

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

CONNECTICUT

Open seasons:[23]	*Dates inclusive*
Hare, rabbit (except European, Belgian, or German hare and jack rabbit, no close season)	Nov. 1-Dec. 15.
Gray squirrel	Oct. 20-Nov. 23.
Partridge or ruffed grouse, Mongolian, Chinese, or English pheasant (male), quail	Oct. 20-Nov. 23.
Woodcock	Oct. 20-Nov. 19.
Duck, goose (except Ross's goose, cackling goose, and snow geese) brant, coot (mudhen)	Nov. 1-Nov. 30.[24]
Wilson's snipe or jacksnipe	Oct. 1-Oct. 31.[24]
Rail and gallinule, other than coot	Sept. 1-Nov. 30.[24]

No open season: Deer,[25] Hungarian partridges (Oct. 20, 1933); pheasant hens, doves, swans, Ross's and cackling geese, snow geese, wood duck, eider ducks, auks, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game, $10.35; game and fish, $14.35; fish, $5.35; resident of State charging fee in excess of $5.35 pays same fee in Connecticut. Resident citizen: Game, $3.35; game and fish, $5.35; fish, $3.35. Issued by city, town, or borough clerk. Hunting license not issued to persons under 16, and fishing license not required of such persons but permits required to fish in State-leased waters. Resident and his children may hunt or fish during open season without license on land on which he is actually domiciled, if such land is not used for club shooting or fishing purposes. Licensee must report amount of game killed, and must wear license button on outer garment. Alien: Not permitted to hunt; fish, $5.35. Taxidermist, $5. Nonresident who owns real estate in Connecticut assessed at not less than $1,000, or lineal descendant of such nonresident pays same fee as resident for fishing license. Alien owning real estate assessed at not less than $500 pays same fee as resident for fishing license.

Bag limits and possession: Five gray squirrels a day, 30 a season; 3 hares or rabbits a day, 30 a season; 2 ruffed grouse a day, 15 a season; 2 pheasants a day, 15 a season; 3 quail a day, 10 a season; 15 ducks, 4 geese, including brant, 4 woodcock a day; 20 Wilson's snipe, 25 coot, 25 sora, and 25 of all other rails and gallinules, but not more than 15 of any one species a day. Possession of more than daily bag limit of game prima facie evidence of violation, but not more than 30 ducks and 8 geese, including brant, may be possessed at any one time. Resident may possess during first 10 days of close season, for his own use and not for sale, game lawfully taken.

Interstate transportation: Export of all protected game prohibited, provided a licensee under permit may export game lawfully killed and possessed, when tagged to show name, address, and license number of shipper, if not for sale; but not more than two days' limit of migratory birds may be exported in any one calendar week.

Game taken outside of State and legally exported may be possessed at any time, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season. Importer must obtain from superintendent of fisheries and game a permit to import game.

Sale: Sale of all protected game prohibited, except game (other than migratory game birds) legally taken and transported from a State or country that does not prohibit sale or exportation of such game may be bought or sold under regulations of board of fisheries and game

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

DELAWARE

Open seasons:[26]	*Dates inclusive*
Rabbit, hare, quail, partridge	Nov. 15-Dec. 31.
Squirrel (fox, black, gray)	Sept. 1-Oct. 15.
Dove (see exception)	Sept. 1-Dec. 15.[27]
Exception. In New Castle County	Sept. 1-Dec. 1.[27]
Woodcock	Nov. 15-Dec. 15.
Duck, goose (except Ross's goose, cackling goose, and snow geese), brant, coot	Nov. 16-Dec. 15.[27]
Wilson's snipe or jacksnipe	Oct. 16-Jan. 15.[27]
Rail and gallinule other than coot	Sept. 1-Nov. 30.[27]

No open season: Hungarian partridges or pheasants, swans, Ross's and cackling geese, snow geese, wood duck, eider ducks, reedbirds, bitterns, sand-hill cranes, grebes, gulls, herons, loons, murres, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game, $15.50; fish, $5 (not required in Delaware River or Bay). Resident: Game and fish, $1.10 (required outside county of residence). Issued by commission. Resident landowner may hunt or fish during open season on own land without license. Unlawful to hunt on land of another without permission from owner or occupant. Fishing license not required of certain excursionists. Nonresidents who own or lease property at seaside summer resorts and their relatives, friends, and patrons sojourning at such resorts may fish for nongame fish and hunt on shores of such resorts without license during open season, between June 1 and September 30. Nonresident licensees must wear license-plate or button on outer garment.

Bag limits and possession: Six in all of rabbits, hares, and squirrels, 15 ducks, 4 geese including brant, 20 Wilson's snipe, 4 woodcock, 25 coots, 25 sora, 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, and not more than 50 in all of sora and other rails combined; 12 birds of any other species a day. Possession of migratory birds permitted during first 10 days of close season, but not more than 30 ducks and 8 geese including brant, may be possessed at any one time; other game during first 5 days thereof.

Interstate transportation: Licensee may carry or ship openly within or out of State in any one week not more than 10 rabbits, 10 squirrels, 50 rails, and 20 birds or fowls of any other species legally killed, but not more than 8 geese including brant, or 8 woodcock may be shipped or transported in one week.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of all protected game prohibited, provided a resident may sell in his own county 20 rabbits a season, lawfully taken by him. Rabbits coming from without State may be sold from November 15 to December 31.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been scattered to attract them

---

[23] *Connecticut:* Governor may suspend open seasons during time of drought, and board of fisheries and game may close season on quail or ruffed grouse when in danger of extermination.

[24] Season on migratory game birds opens at 12 o'clock noon.

[25] Owners of agricultural lands, member of family, or employee may kill deer with a shotgun or, under permit, with a rifle, at any time on such lands when deer are damaging fruit trees or growing crops, but such killing or wounding must be reported to the board of fisheries and game within 12 hours.

[26] *Delaware:* Minors under 15 are not permitted to hunt game with shotgun or rifle unless accompanied by an adult lawfully hunting.

[27] Season on migratory game birds opens at 12 o'clock noon.

DISTRICT OF COLUMBIA [28]

Open seasons:	*Dates inclusive*
Deer meat (sale or possession)	Sept. 1–Jan. 1.
Rabbit (except English rabbit, Belgian hare), squirrel (sale or possession)	Nov. 1–Feb. 1.
Marsh blackbird	Sept. 1–Feb. 1.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Nov. 16–Dec. 15.[29]
Wilson's snipe or jacksnipe	Nov. 1–Jan. 15.[29]
Woodcock	Nov. 10–Dec. 10.[29]
Rail and gallinule	Sept. 1–Nov. 30.[29]

No open season: Doves, Ross's and cackling geese, swans, wood duck, reedbirds bitterns, grebes, gulls, herons, loons, murres, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Bag limits and possession: Fifteen ducks, 4 geese, including brant, 20 Wilson's snipe, 4 woodcock, 25 coots, 25 sora, 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day. Not more than 30 ducks and 8 geese, including brant, may be possessed. Possession of migratory birds permitted during first 10 days of close season; quail, November 1 to March 15; ruffed grouse or pheasant (except English or other imported pheasants raised in inclosures, possession unrestricted), and wild turkey, November 1 to December 26; prairie chicken (pinnated grouse), September 1 to March 15.

Interstate transportation: Export of migratory game birds in excess of two days' bag limit in any one calendar week prohibited.

Migratory game birds taken outside of District and legally exported may be possessed during open season where taken and first 10 days of close season. Other game may be possessed during open season in District.

Sale: Sale of all game birds prohibited. Deer, rabbit, and squirrel may be sold during open season.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

FLORIDA

Open seasons: [30]

	Dates inclusive
Deer (male) (see exception)	Nov. 20–Dec. 31.
Exception: In Collier (1934), Pinellas (1933), and Sumter (1934) Counties	No open season.
Cat squirrel, wild turkey, quail (see exceptions)	Nov. 20–Feb. 15.
Exceptions: Wild turkey in Collier (1934), Pinellas (1933), and Sumter (1934) Counties	No open season.
Quail in Pinellas County (1933)	No open season.
Quail in Collier County	Nov. 20–Dec. 31.
Doves (see exceptions)	Nov. 20–Jan. 31.[31]
Exceptions: In Dade, Monroe, and Broward Counties	Sept. 16–Nov. 15[31]
In Pinellas County (1933)	No open season.
Duck, goose (except Ross's, cackling, and snow geese), brant, coot (see exceptions)	Nov. 20–Dec. 19[31] [32]
Exception: In Pinellas County (1933)	No open season.
Wilson's snipe or jacksnipe (see exception)	Nov. 20–Jan. 15.[31]
Exception: In Pinellas County (1933)	No open season.
Rails, other than coot and gallinule (see exception)	Sept. 15–Nov. 30.[31] [33]
Exception: In Pinellas County (1933)	No open season.
Gallinules (see exception)	Nov. 20–Nov. 30.[33]
Exception: In Pinellas County (1933)	No open season.

No open season: Does, gray, black, or fox squirrels (1932), ruffed grouse, introduced pheasants, and other foreign game birds; swans, Ross's, cackling, and snow geese, wood duck, reedbirds, bitterns, sand-hill and whooping cranes, gannets, grebes, gulls, herons, jaegers, loons, petrels, shearwaters, terns, woodcock, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game, $25.50 (State); fresh-water fish, $10.50 (State), $3.25 (county license). Resident: Game, $8 (State); $3.25 (county other than county of residence), $1.25 (county of residence); fresh-water fish, $3.25 (not required in county of residence), $1.25 (county other than county of residence). Duplicate license, fee 25 cents. Additional hunting and fishing licenses required in Sumter County—Residents of county, $2, nonresidents $5. Special county license (fee $10 each county) required for nonresidents fishing in Choctawhatchee River and its tributaries in Holmes, Walton, and Washington Counties. Issued by county judge. License not required of person under 15, nor of resident Confederate veteran who is entitled to State pension, nor of landowner or member of his family in county of residence on own land or that of parent, wife, or child; nor of resident over 65. Guide, $10, alien, $50; issued by State game commissioner. Boats (renting for hunting or fishing): Under 18 feet in length, $2.50 each; 18 to 21 feet, $4 each; 21 to 25 feet, $15 each; over 25 feet, $25 each; issued by State game commissioner. Licensee must report to State game commissioner number and kind of game taken.

Bag limits and possession: One deer a day, 2 a season; 2 turkeys a day, 5 a season; 200 of any other species of game birds or animals a season; 15 cat-squirrels, 15 quail, 25 doves, 15 ducks, 4 geese, including brant, 15 Wilson's snipe, 20 coots, and 25 in all of rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, a day. Game lawfully taken may be possessed during the open season and first 5 days of close season, but not more than two days' limit of game may be in possession at one time.

Interstate transportation: Export of all protected game prohibited, except nonresident licensee may export game lawfully taken by himself but not to exceed 2 deer and 5 turkeys a season nor more than two days' limit of other game during any one calendar week.

Sale: Sale of all game prohibited, except that reindeer meat may be brought into State and sold under permit from State game commissioner.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in hunting wild geese.

---

[28] *District of Columbia:* Hunting prohibited in District by act of June 30, 1906, except on marshes of Eastern Branch above Anacostia Bridge and below Aqueduct Bridge (Key Bridge) on Virginia side of Potomac, but in these areas no birds may be shot within 200 yards of any bridge or dwelling.

[29] Season on migratory game birds opens at 12 o'clock noon.

[30] *Florida:* State game commissioner on request of county commissioners may extend State seasons on ducks and mourning doves to full period allowed by Federal regulations.

[31] Season on migratory game birds opens at 12 o'clock noon.

[31] Season on migratory game birds opens at 12 o'clock noon.

[32] Ducks may be taken on Iamonia, Jackson, and Miccosukee Lakes in Leon and Jefferson Counties only on Monday, Wednesday, and Friday of each week during open season.

[33] Rails may be hunted only on salt-water marshes.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been scattered to attract them.

Unlawful to shoot quail while they are on the ground.

GEORGIA

Open seasons:	*Dates inclusive*
Deer [34] (male, with exposed horns), (see exception)	Nov. 15–Jan. 5.
Exception: In Bartow, Catoosa, Chattooga, Chattahoochee, Dade, Dawson, Fannin, Floyd, Gilmer, Gordon, Habersham, Lumpkin, Marion, Murray, Muscogee, Pickens, Rabun, Schley, Stephens, Stewart, Towns, Union, Walker, White, and Whitfield Counties	No open season.
Bear	Nov. 20–Feb. 1.
Rabbit	No close season.
Cat squirrel (see exception)	Oct. 1–Jan. 15.
Exception: In Catoosa, Chattooga, Dade, Dawson, Fannin, Gilmer, Gordon, Habersham, Lumpkin, Murray, Pickens, Rabun, Stephens, Towns, Union, Walker, White, and Whitfield Counties	Aug. 15–Jan. 15.
Opossum	Oct. 1–Feb. 1.
Quail,[35] wild turkey	Nov. 15–Feb. 15.
Doves	Sept. 1–Sept. 30.[36] Nov. 20–Jan. 31.[36]
Woodcock	Dec. 1–Dec. 31.[36]
Wilson's snipe or jacksnipe	Nov. 1–Jan. 15.[36]
Duck, goose (except Ross's goose, cackling goose, and snow geese), brant, coot	Nov. 16–Dec. 15.[36]
Rail (marsh hen) and gallinule, other than coot	Sept. 1–Nov. 30.[36]

No open season: Does and fawns, fox squirrels, grouse, native pheasants, introduced game birds,[37] swans, Ross's goose, cackling goose, snow geese, wood duck, eider ducks, reedbirds, bitterns, sandhill and whooping cranes, gannets, grebes, gulls, herons, loons, petrels, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting licenses: Nonresident, $25 (State), $10 (county of issue); resident, State, $3.25; county, $1 (good only in county of residence). License not required of landowners or tenants and their families with consent of landowner to hunt on own land. Issued by commissioner, county warden, and county ordinary.

Bag limits and possession: Two deer, 2 turkeys a season; 15 cat squirrels, 20 quail a day, 40 a week or in possession; 15 ducks; 4 geese, including brant; 20 Wilson's snipe, 4 woodcock, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species, 25 doves a day. Possession of migratory birds, except woodcock, permitted during first 10 days of close season but not more than 30 ducks and 8 geese, including brant, may be possessed at any one time.

Interstate transportation: Export of all protected game prohibited; provided nonresident licensee may take out in personal possession, game lawfully killed but not more than two days' limit of migratory birds may be exported in any one calendar week.

Game taken outside of State and legally exported may be imported and possessed under a permit, in like manner as game taken in State. Permits issued by game and fish commissioner.

Sale: Sale of reedbirds (ricebirds) and all protected game prohibited.

Miscellaneous: Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

HAWAII

Open seasons:	*Dates inclusive*
Deer	Apr. 1–Oct. 31.
Quail (except bobwhite) in Maui County	Nov. 1–Jan. 31.
In Hawaii County	Dec. 1–Jan. 31
In Kauai County, and city and county of Honolulu	No open season.
Pheasant (male) in Maui, Kauai, and Honolulu Counties	Nov. 1–Jan. 31.
In Hawaii County	Dec. 1–Jan. 31.
Wild dove, wild pigeon in Honolulu [38] County	Sept. 1–Dec. 31.
In Hawaii County	July 1–Jan. 31.
In Maui and Kauai Counties	July 1–Dec. 31

No open season: Wild ducks and geese, shorebirds, wild peacock, and blue-eyed, top-knot, bar-shouldered, green-winged, and bronze-winged doves, except as permitted by board, hen pheasants, wild African ringneck doves, chachalacas, curassows, guans, guinea fowl, bobwhite quail; quail in Kauai and Honolulu Counties.

Hunting and fishing licenses: County licenses: Nonresident citizen or declarant alien. Game, $10; fish, $2.50. Resident citizen: Game, $5; fish, $2.50. Alien: Game, $25; fish, $5. Hunting and fishing licenses issued by county treasurer. Permission of owner or occupant required to hunt on lands of another.

Bag limits and possession: *Hawaii County:* Cock pheasants, 5 a day, 25 a season, quail, 15 a day, 30 in 7 consecutive days; doves and pigeons, 20 a day, 50 in 7 consecutive days. *Honolulu County;* Cock pheasants, 3 a day; doves and pigeons, 20 a day. *Kauai County:* Cock pheasants, 3 a day; doves and pigeons, 15 a day. *Maui County:* Cock pheasants, 5 a day, 10 in 7 consecutive days; quail, 10 a day, 25 in 7 consecutive days; doves and pigeons, 15 a day, 45 in 7 consecutive days.

IDAHO

Open seasons: [39]	*Dates inclusive*
Elk, in Clearwater and Idaho Counties	Oct. 5–Nov. 10.
In Franklin County	Oct. 20–Oct. 30.
In Clark, Fremont, Jefferson, and Madison Counties	Dec. 1–Dec. 15.
In Teton County	Oct. 15–Nov. 1.
Deer, in Adams, Blaine, Boise, Butte, Custer, Elmore, Gem, Lemhi, and Valley Counties, and in Idaho County south of Main Salmon and east of Little Salmon	Oct. 1–Oct. 26.
In remainder of Idaho County	Oct. 5–Nov. 10.
In Clearwater County north and west of North Fork and Little North Fork Clearwater River	Oct. 15–Dec. 1.
In rest of Clearwater County	Oct. 5–Nov. 15.
In Clark, Fremont, Jefferson, Madison, and Teton Counties	Oct. 11–Oct. 20.
In Benewah, Bonner, Boundary, Kootenai, Latah, Lewis, Nez Perce, and Shoshone Counties	Nov. 1–Nov. 30.
In Bannock, Bear Lake, Caribou, Franklin, Oneida, Counties	Oct. 20–Oct. 24.
In Washington County	Oct. 1–Oct. 26.

---

[34] *Georgia:* Killing of a deer must be reported to warden of county in which killed or to commissioner of game and fish at Atlanta within 5 days.

[35] Quail in Pierce County may be hunted only on Tuesday and Friday of each week.

[36] Season on migratory game birds opens at 12 o'clock noon.

[37] Landowner may permit shooting of nonnative pheasants Nov. 20–Feb. 15.

[38] *Hawaii:* Hunting prohibited in city and county of Honolulu except on Saturdays, Sundays, and legal Territorial holidays.

[39] *Idaho:* State game warden may close season in any county or part thereof on any species of game or fish threatened with extinction.

Open seasons—Continued.	*Dates inclusive*
Mountain sheep (ram only—see special license) in Valley and Lemhi Counties	Oct. 15–Oct. 25.
Mountain goat, in Adams, Blaine, Boise, Butte, Custer, Elmore, Lemhi, Valley, Idaho, and Clearwater Counties	Oct. 10–Oct. 20.
Bear (see exception)	No close season.
Exception: In Benewah, Bonner, Boundary, Clearwater, Kootenai, Latah, Lewis, Nez Perce, and Shoshone Counties	Sept. 1–May 31.
Chinese, ring-necked, or Mongolian pheasant, in Ada, Adams, Blaine, Canyon, Cassia, Elmore, Gem, Gooding, Jerome, Lincoln, Minidoka, Owyhee, Payette, Twin Falls, and Washington Counties	Oct. 15–Nov. 15.
In Bannock, Bingham, Bonneville, Fremont, Jefferson, and Madison Counties, and Power County north and west of Snake River	Nov. 1–Nov. 10.
In Clearwater, Idaho, Latah, and Lewis Counties	Nov. 1–Nov. 20.
In Nez Perce County (Sunday, Wednesday, and Friday only)	Nov. 1–Nov. 20.
Ruffed grouse, native pheasant, blue grouse, in Adams, Blaine, Cassia, Gem, Jerome, Lincoln, Minidoka, Owyhee, Twin Falls, Valley, and Washington Counties	Aug. 1–Aug. 10.
In Bannock, Bear Lake, Bingham, Bonneville, Caribou, Clark, Franklin, Fremont, Jefferson, Lemhi, Madison, Oneida, Power, and Teton Counties	Aug. 24–Sept. 1.
In Clearwater, Idaho, Lewis, and Nez Perce Counties	Sept. 1–Sept. 10.
In Benewah, Boundary, Bonner, Kootenai, and Shoshone Counties	Oct. 1–Oct. 10.
Sharp-tailed grouse, in Adams, Cassia, Gem, Jerome, Minidoka, Owyhee, Twin Falls, Valley, and Washington Counties	Aug. 1–Aug. 10.
In Bannock, Bear Lake, Caribou, Franklin, Oneida, and Power Counties	Aug. 24–Sept. 1.
Sage hen, in Adams, Cassia, Custer, Gem, Jerome, Lemhi, Minidoka, Twin Falls, Valley, and Washington Counties	Aug. 1–Aug. 10.
In Bannock, Bear Lake, Bingham, Bonneville, Caribou, Clark, Franklin, Fremont, Jefferson, Madison, Oneida, Power, and Teton Counties	Aug. 20–Sept. 1.
Hungarian partridge, in Benewah, Bonner, Boundary, and Kootenai Counties	Nov. 1–Nov. 15.
In Clearwater, Idaho, Latah, and Lewis Counties	Nov. 1–Nov. 20.
In Nez Perce County (Sunday, Wednesday, and Friday only)	Nov. 1–Nov. 20.
Quail, in Lemhi County	Oct. 20–Oct. 31.
In Ada, Canyon, Elmore, Gem, Payette, Twin Falls, and Washington Counties	Nov. 1–Nov. 10.
In Nez Perce County (Sunday, Wednesday, and Friday only)	Nov. 1–Nov. 10.
Dove	Sept. 1–Dec. 15.[40]
Duck, goose (except Ross's goose and cackling goose), brant, and coot	Oct. 1–Oct. 31.[40]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[40]
Rail and gallinule, other than coot	Sept. 1–Nov. 30.[40]

No open season: Deer, elk, mountain goats, mountain sheep (except as above); moose, antelope, caribou, buffalo, spotted fawns, calf elk; quail, grouse (except as above), imported pheasants (except Chinese, ring-necked, or Mongolian pheasants as above); prairie chickens, Ross's and cackling geese, swans, wood duck, bitterns, little brown and sand-hill cranes, grebes, gulls, herons, loons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game and fish, $50; bird, $10; fish, $5. Alien: Game and fish, $75; fish, $10; gun license, $5. Resident: Game and fish, $2. Special licenses for mountain sheep in Valley and Lemhi Counties: Nonresident, $50; resident, $25. Issued by warden, deputy, or authorized agent. Fishing license not required of minors under 14 years of age; and veterans of Civil War may hunt and fish without a license. Persons under 12 prohibited from possessing gun afield. Taxidermist, $10.

Bag limits and possession: One deer, 1 elk, 1 mountain goat, 1 mountain sheep a season; 6 quail, 4 in all of Chinese, ring-necked or Mongolian pheasants; 8 Hungarian partridges, 4 sage hens, native pheasants, or grouse, 15 ducks, 4 geese, including brant, a day, or in possession; 25 doves, 20 Wilson's snipe, 25 coots, 25 sora and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day. Migratory waterfowl may be stored by owner, under affidavit and storage permit, during open season and 10 days thereafter. Game animals may not be shipped, transported, or carried more than 5 days after close of open season.

Interstate transportation: Export of all protected game prohibited, provided a hunter may export under hunting-license coupon, big game lawfully taken; and one day's limit of game birds may be transported in personal possession but may not be shipped or mailed. Big game once shipped within State may be exported under a 50-cent permit obtained from game warden or deputy. Mounted heads and stuffed birds legally obtained may be exported under a reshipping permit. Shipment of game by parcel post prohibited.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State, if identification tags or shipping or possession permits are attached.

Sale: Sale of all protected game prohibited. Hides, heads, and horns may be sold under permit.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been scattered to attract them.

ILLINOIS[41]

Open seasons:	*Dates inclusive*
Rabbit	Nov. 10–Jan. 31.
Squirrel, in northern zone	Sept. 1–Dec. 1.
In central zone	Aug. 1–Dec. 1.
In southern zone	July 1–Dec. 1.
Quail (bobwhite)	Nov. 10–Dec. 10.
Prairie chicken	Nov. 10–Nov. 15.

---

[40] Season on migratory game birds opens at 12 o'clock noon.

[41] *Illinois; Southern zone* includes Madison, Bond, Fayette, Effingham, Jasper, Crawford, and all counties south. *Central zone* includes Hancock, McDonough, Fulton, Tazewell, McLean, Ford, Vermilion, and all counties south to northern boundary of southern zone. *Northern zone* includes rest of counties of State.

Open seasons—Continued.	*Dates inclusive*
Introduced pheasant (cocks)	Nov. 10–Nov. 15.
Dove	Sept. 1–Sept. 30.[42]
Duck, goose (except Ross's goose and cackling goose), brant, coot	Nov. 1–Nov. 30.[42]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[42]
Rail and gallinule, other than coot	Sept. 16–Nov. 30.[42]

No open season: Deer (1939); wild turkeys, introduced pheasant hens, sand grouse, ruffed grouse (partridge), blue, mountain, and valley quail, Hungarian partridges, capercailzie, black grouse, woodcock, swans, Ross's and cackling geese, wood duck, eider ducks, bitterns, little brown, sand-hill, and whooping cranes, grebes, gulls, herons, jaegers, loons, murres, petrels, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident citizen: Game, $15.50; fish, $3. Resident citizen: Game, $1; fish, 50 cents. Hunting licenses not issued to aliens, nor to minors under 16 without written consent of parent or guardian. Issued by village, county, or city clerk. Hunting club, $10, issued by department of conservation. Fishing license not required of persons under 21. Owners, their children, and tenants in actual residence may hunt or fish with hook and line during open season on own land without license. Permission required to hunt on lands of another. Taxidermist, $5.

Bag limits and possession: Ten squirrels, 15 rabbits, 12 quail, 3 prairie chickens, 2 cock pheasants, 15 doves, 15 snipe, 15 in all of coots and gallinules, 15 rails but not more than 25 in all of rails, coots, and gallinules; 15 ducks, 4 geese, including brant a day. Limit, in possession, 20 squirrels, 36 quail, 9 prairie chickens, 6 cock pheasants, 25 doves, 50 snipe, 60 coots and gallinules, 60 rails, 30 ducks, 8 geese including brant.

Interstate transportation: Export of all protected game (except rabbit) prohibited; provided, nonresident licensee may take from State 50 game birds or animals, if carried openly for inspection, but not more than two days' limit of migratory birds may be exported in any one calendar week. Resident may carry out game under his license.

Deer lawfully killed and shipped may be brought or shipped into State, and rabbits may be imported November 10 to February 5.

Sale: Sale of all protected game (except rabbit, November 10–February 5) prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

INDIANA

Open seasons:	*Dates inclusive*
Rabbit	Nov. 11–Jan. 10.
Squirrel (except red squirrel, no close season)	Aug. 1–Oct. 14.
Quail, ruffed grouse	Nov. 10–Dec. 20.
Prairie chicken	Oct. 16–Nov. 15.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 16–Nov. 15.[43]
Woodcock	Oct. 15–Nov. 14.[43]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[43]
Rail and gallinule, other than coot	Sept. 1–Nov. 30.[43]

No open season: Deer, Hungarian partridges, introduced pheasants, wild turkeys, doves, Ross's and cackling geese, swans, wood ducks, bitterns, sand-hill and whooping cranes, gannets, grebes, gulls, herons, jaegers, loons, murres, petrels, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game, fish, and trapping, $15.50; fish, $2.25. Resident: Game, fish, and trapping, $1. Issued by clerk circuit court and by superintendent and his agents. Permits to hunt and fish without license issued free to honorably discharged soldiers, sailors, and marines who are residents of State, resident owners of farm land, their children living with them, and tenants residing thereon may hunt during open season on own land without a license. No license required of persons to fish in county of residence. All persons under 18 may fish without license. Permission required to hunt on lands of another.

Bag limits and possession: Ten rabbits, 5 squirrels (except red squirrels, no limit), 15 quail, 5 prairie chickens, 15 ducks, 4 geese, including brant, a day, 20 Wilson's snipe, 4 woodcock, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day. Not more than 18 woodcock, 30 ducks, 8 geese, including brant, or three days' limit of other migratory game birds may be possessed at one time by one person. Possession of migratory game birds permitted during first 10 days of close season.

Interstate transportation: Export of deer, quail, grouse, prairie chicken, pheasant, wild turkey, and migratory game birds prohibited, except any licensee may export 15 game birds in the aggregate of all kinds, lawfully taken by himself, each day he hunts in State, but not more than daily limit of any one species, and not more than 2 days' limit in any one calendar week, if carried openly for inspection together with his license or if the package is tagged or clearly labeled with names and addresses of shipper and consignee and an accurate statement of number and kind of birds.

Deer, turkeys, and rabbits taken outside of State and legally exported may be possessed at any time; other game legally exported may be possessed in like manner as game taken in State.

Sale: Sale of squirrels (except red squirrels), quail, prairie chickens, introduced pheasants, Hungarian partridges, and migratory birds prohibited. Sale of rabbits prohibited during close season.

Miscellaneous: Shooting on highways or by aid of searchlight prohibited.

Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

IOWA

Open seasons:	*Dates inclusive*
Squirrel	Oct. 1–Dec. 31.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 20–Nov. 19.[44]
Woodcock	Oct. 15–Nov. 14.[44]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[44]
Rail and gallinule, other than coot	Sept. 16–Nov. 30.[44]

No open season: Deer, introduced pheasants,[45] Hungarian partridges, quail, prairie chickens, ruffed grouse or pheasants, wild turkeys, turtle doves, Ross's and cackling geese, swans, wood duck, eider ducks, bitterns, little brown, sand-hill, and whooping cranes, grebes, gulls, herons, jaegers, loons, murres, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident or alien, game, $15; fish, $3. Resident citizen, game and fish, $1. Issued by county recorder and authorized agents. Fishing license required of nonresidents over 16 and resident males over 18 to fish in State waters. License not granted to persons under 18 without written consent of parent or guardian. Owners or tenants of farm lands and their wives or children may hunt and fish on own lands during open season without license. Unlawful to hunt on cultivated or inclosed lands of another without permission from owner.

---

[42] Season on migratory game birds opens at 12 o'clock noon.

[43] Season on migratory game birds opens at 12 o'clock noon.

[44] *Iowa:* Season on migratory game birds opens at 12 o'clock noon.

[45] Upon petition of 150 farmers and land-owners in any county who have suffered damage by Chinese, Mongolian, English, or ring-necked pheasants, State game warden may fix an open season for such county not exceeding 5 days during which a person may kill not exceeding 3 such pheasants a day but not more than 10 may be had in possession at any one time.

Bag limits and possession: Fifteen squirrels a day or in possession; 15 ducks, 4 geese including brant, a day, 21 waterfowl in possession, except that not more than 8 geese including brant may be possessed at any one time; 15 Wilson's snipe, 4 woodcock, 15 each of rails, coots, and gallinules a day, but not more than 15 in all of rails and gallinules a day; 15 of each species in possession. Possession permitted during first 10 days of close season.

Interstate transportation: Export of all protected game prohibited, except that nonresident may take from State not more than 15 game birds or animals, if carried openly for inspection, and if hunting license be shown on request, but not more than 8 woodcock or 8 geese including brant may be exported in any one calendar week.

Game taken outside of State and legally exported may be possessed at any time, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season. After expiration of first 10 days of close season in State, possessor of game must show lawful taking.

Sale: Sale of all protected game prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

KANSAS

Open seasons:[46]	*Dates inclusive*
Quail	Nov. 20–Nov. 30.
Prairie chicken (two days)	Oct. 20 and 21.[47]
Dove	Nov. 1–Dec. 15.[48]
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 20–Nov. 19.[48]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[48]
Rail, other than coot and gallinule	Sept. 1–Nov. 30.[48]
Gallinule	Oct. 1–Nov. 30.[48]

No open season: Deer, antelope, red, gray, and black squirrels, ruffed grouse (partridges), pheasants (English, Mongolian, Hungarian); woodcock; Ross's and cackling geese, swans, wood duck, eider ducks, bitterns, little brown, sand-hill, and whooping cranes, grebes, gulls, herons, loons, terns, upland plover, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game, $7; fish, $3; 15 day fishing license, $1. Resident: Game, $1 county of residence and adjoining counties; statewide, $3; fish, $1. Issued by county clerk. Resident landowner or member of family may hunt or fish on own premises during open season without a license. Fishing license not required of males under 18 or over 70, nor of women. Unlawful to hunt on land of another or on highway or railroad right of way adjacent thereto without consent of owner, unless accompanied by him.

Bag limits and possession: Quail, 10 a day, 25 a season, 5 prairie chickens a day, 10 a season; 15 in all of ducks, Wilson's snipe, coots, and gallinules; 20 doves, 4 in all of geese and brant, 6 rails, a day. Possession of two days' limit of two kinds of game permitted during first five days of close season, but not more than 30 ducks and 8 geese including brant may be possessed at any one time.

Interstate transportation: Export of all protected game birds prohibited, except that a person under hunting license and affidavit of lawful killing and possession may ship to himself not more than two days' limit of two kinds of game taken by himself. Game of not more than two kinds, and not more than two days bag limit, taken outside of State and legally exported may be possessed during open season and first five days of close season.

Sale: Sale of all protected game prohibited.

Miscellaneous: Unlawful to shoot game birds while on the ground or water, unless wounded.

Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been scattered to attract them.

KENTUCKY

Open seasons:	*Dates inclusive*
Rabbit[49]	Nov. 15–Dec. 31.
Squirrel	Aug. 1–Nov. 30.
Quail, ruffed grouse (native pheasant)	Nov. 15–Jan. 1.
Dove	Sept. 1–Dec. 15.[50]
Woodcock	Nov. 15–Dec. 15.[50]
Duck, goose (except Ross's goose and cackling goose), brant, coot	Nov. 16–Dec. 15.[50]
Wilson's snipe or jacksnipe	Nov. 1–Dec. 31.[50]
Rail and gallinule, other than coot	Sept. 1–Nov. 30.[50]

No open season: Deer, elk (1932); introduced pheasants, Hungarian partridges, wild turkeys (1932) Ross's and cackling geese, swans, wood duck, bitterns, sand-hill and whooping cranes, grebes, gulls, herons, jaegers, loons, petrels, terns, and all shore birds (except woodcock and Wilson's snipe).

Hunting and fishing licenses: Nonresident or alien, game, $10.50; fish, $2.50. Resident, game, $1; fish, $1. Issued by county clerk. Resident landowner, tenant, and members of families may hunt on own land during open season without license. Unlawful to enter inclosed lands of another for shooting, hunting, or fishing without consent.

Bag limits and possession: Twelve squirrels a day, 24 in possession at one time; 12 quail a day, 12 in possession for each successive day of hunt; 15 doves a day, 15 in possession for each successive day of hunt; 2 ruffed grouse a day; 15 ducks, 4 geese including brant, 4 woodcock, 20 Wilson's snipe, and 25 in all of rails, coots, and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day. Not more than 30 ducks and 8 geese including brant, may be possessed at any one time.

Interstate transportation: Export of deer, elk, and all game birds prohibited, except that a hunter may transport game lawfully killed and possessed by him, but not more than two days' limit of migratory birds may be exported in any one calendar week.

Game taken outside of State and legally exported may be possessed during open season in State in like manner as game taken in State.

Sale: Sale of quail, partridges, grouse, introduced or native pheasants, Hungarian partridges, wild turkeys, and migratory birds, wherever killed, prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

LOUISIANA

Open season:[51]	*Dates inclusive*
Deer, in Concordia, Avoyelles, Rapides, Vernon, and all parishes north thereof	Dec. 1–Jan. 15.
In parishes south	Nov. 1–Jan. 5.
Bear	Oct. 15–Jan. 5.
Squirrel, chipmunk	Oct. 1–Jan. 15.
Hare, rabbit	Oct. 1–Feb. 29.
Quail	Dec. 1–Feb. 15.
Wild turkey	Mar. 5–Apr. 5.
Woodcock	Dec. 1–Dec. 31.[52]
Dove	Dec. 1–Jan. 31.[52]
Duck, goose (except Ross's goose and cackling goose), brant, coot	Nov. 16–Dec. 15.[52]
Wilson's snipe, rail, gallinule	Nov. 1–Jan. 15.[52]

No open season: Fawns, elk, prairie chickens, introduced pheasants, Ross's and cackling geese, swans, wood duck, bobolinks, bitterns, sand-hill and whooping cranes, gannets, grebes, gulls, herons, loons, petrels, terns, upland plover (papabotte), and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

---

[46] *Kansas:* Seasons and bag limits may be shortened or reduced when deemed advisable by forestry, fish, and game commission.

[47] Season on prairie chicken fixed by commission.

[48] Season on migratory game birds opens at 12 o'clock noon.

[49] *Kentucky:* Rabbits may be taken with dogs or traps (except snares) at any time for a person's own use on his own land, but not for sale or barter.

[50] Season on migratory game birds opens at 12 o'clock noon.

[51] *Louisiana:* Seasons on game may be curtailed in any parish by police juries with consent of commissioner.

[52] Season on migratory game birds opens at 12 o'clock noon.

Hunting and fishing licenses: Nonresident: Game animals and resident game birds, $50, migratory game birds, $25, fish, $5 (annual), $1 (week). Resident, $1. Club or association, $5. Alien. General, $50, game birds, $25, fish, $1. Issued by tax collectors. License does not authorize hunting on land of another without his written consent.

Bag limits and possession: Deer, bear, 1 each a day, 5 each a season; squirrels and chipmunks combined, 10 a day, 120 a season; 1 turkey a day, 5 a season; quail, 15 a day, 120 a season; dove, 25 a day, 300 a season; ducks, 15 a day, 300 a season; geese and brant combined, 4 a day, 100 a season; Wilson's snipe, 20 a day, 240 a season; coots, 25 a day, 300 a season; sora, 25 a day, 300 a season; rails and gallinules combined, 25 a day but not more than 15 of any one species of rails (other than sora) and gallinules a day, 300 a season; woodcock, 4 a day, 22 a season.

The daily bag limits include all birds taken by guide or other person who for hire accompanies or assists a hunter in taking them. Game in excess of one day's limit in possession must be tagged. Possession of game birds permitted during first 10 days of close season, but not more than 30 ducks and 8 geese, including brant, may be possessed at any one time.

Interstate transportation: Export of all protected game prohibited; provided a nonresident licensee may carry with him out of the State under his license and tag two days' limit of game birds, if not for sale. All game and all packages containing game must be tagged to show kind and number, names of consignor and consignee, initial point of billing, and destination.

Game taken outside of State and legally exported may be possessed at any time, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Sale: Sale of all game (except hares and rabbits during open season and 10 days thereafter) prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been scattered to attract them.

MAINE

Open seasons: [53]	*Dates inclusive*
Deer, black bear (see exceptions)	Nov. 1-Nov. 30.
Exceptions: In Hancock, Washington, Penobscot, Somerset, Piscataquis, Franklin, and Oxford Counties	Nov. 1-Dec. 15.
In Aroostook County	Oct. 16-Nov. 30.
Hare, rabbit (see exception)	Oct. 1-Mar. 31.
Exception: In Androscoggin, Cumberland, Sagadahoc, and York Counties	Oct. 1-Feb. 28.
Gray squirrel	Oct. 1-Oct. 31.[54]
Ruffed grouse, partridge	Oct. 1-Nov. 9.
Woodcock	Oct. 1-Oct. 31.

Open seasons—Continued.	*Dates inclusive*
Duck, goose (except Ross's goose, cackling goose, and snow goose) brant, coot (see exception)	Oct. 1-Oct. 31.[55]
Exception: Waterfowl, in Back Bay, Portland, above Grand Trunk Railway bridge	No open season.
Wilson's snipe or jacksnipe	Oct. 1-Dec. 31.[55]
Rail (other than coot), and gallinule	Sept. 1-Nov. 30.[55]

No open season: Moose, caribou, Hungarian partridges, pheasants, black game, capercailzie, cock of the woods, doves, Ross's and cackling geese, snow geese, swans, wood duck, eider ducks, auks, bitterns, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident or alien: Big game, $15.15, small game, $5.15. Not issued to person under 18 without consent of parent or guardian. Holder of small-game license may exchange it for big-game license by paying difference in cost. Nonresident may not enter unorganized townships (except public camp sites maintained by Maine Forestry Department) May 1-Nov. 30, and kindle fires while camping, fishing, or hunting, or hunt in such territory during open season unless accompanied by registered guide. Nonresident fishing, $3.15 for 30 days; $5.15 for season; nonresident between 10 and 14 years of age, $1.15 season. Aliens who pay taxes on real estate and who have resided in State two years continuously prior to application may obtain resident hunting and fishing licenses. Taxidermist: Resident citizen, $5; resident alien, $25. Guide licenses: Nonresident, $20; resident, $1. Must not guide more than five nonresidents hunting at one time. Sporting camp, $5. Shipping licenses (within State): Resident, deer, $2; one pair of game birds in seven days, 50 cents. Issued by commissioner

Resident combination hunting and fishing, $1.15; hunting, 65 cents; fishing, 65 cents. Resident or member of immediate family may hunt or fish without a license during open season on own land used exclusively for agricultural purposes and on which he is actually domiciled. License not required of resident under 16 when accompanied by parent or guardian. Issued by city, town, and plantation clerks.

Bag limits and possession: One deer a season; 4 ruffed grouse a day, 25 a season; 10 ducks, 10 Wilson's snipe, 4 woodcock a day or in possession; 4 geese, including brant, a day, 8 in possession; 25 sora, 25 in all of other rails, 25 coots and gallinules but not more than 15 of any one species of rails (other than sora) and gallinules a day. Transportation of migratory game birds must be completed within five days after close of season; reasonable time allowed after close of season to transport other game to home of owner. Deer or moose may not be used or had in possession in lumber camps. Deer must be transported open to view, tagged, and labeled with name and address of and be accompanied by owner. Resident may ship deer unaccompanied under special tag (fee, $2). Possession of migratory birds limited to first 10 days of close season; deer legally procured may be possessed during close season.

Interstate transportation: Export of all protected game prohibited; provided, a resident of the State, under transportation tag (fee, $5) may take with him out of State game birds lawfully killed by himself. A nonresident may export, open to view, 1 deer, 4 partridges, 10 ducks, 10 snipe, 4 woodcock and hares lawfully taken by himself, under hunting-license tags, when such tags bear written approval of a warden, deputy, or the commissioner. Nonresident licensee may also ship out 1 pair of game birds a month under a special 50-cent license.

---

[53] *Maine:* Commissioner may make local regulations restricting hunting, and governor may suspend hunting or fishing seasons during drought.

All hunting is prohibited on Kineo Point and Mount Katahdin, Piscataquis County; on Prouts Neck, on Richmond Island, and locally on Cape Elizabeth and in town of Scarboro, Cumberland County; southern point Swan Island; Bartlett Island, Hancock County. (See State laws for details and other protected areas.)

[54] Squirrels protected in parks and in compact or built-up portions of cities and villages.

[55] Season on migratory game birds opens at 12 o'clock noon.

Moose or caribou, or parts thereof, taken outside of State and legally exported may be imported under license of commissioner for consumption or mounting, but not for sale. Deer properly tagged where taken and game birds may be imported under permit of commissioner and possessed in like manner as game killed in State. Permits and shipping tags issued by commissioner of inland fisheries and game.

Sale: Sale of all protected game birds prohibited; unlawful to sell, give away, or accept deer for export. Local provision dealer, under $5 license, may purchase two deer for retail to his local customers. Deer skins and skins with heads attached may be bought and sold by residents under $25 license. Heads, when detached from skins with which purchased, may be sold to licensed taxidermists.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

MARYLAND

Open seasons:[56]	*Dates inclusive*
Deer (males, with 2 or more points to one antler). in Allegany County, and within game reserves inclosed with 7-foot fence in Washington County	Dec. 1–Dec. 15.
In Garrett County	Dec. 1–Dec. 3.
Rabbit or hare, quail (partridge). ruffed grouse (pheasant), English or Mongolian pheasant, wild turkey (see exception)	Nov. 15–Dec. 31.
Exception: Wild turkey, quail in Garrett County (1933)	No open season.
Squirrel (see exception)	Sept. 15–Oct. 15. Nov. 15–Dec. 24.
Exception: In Allegany, Cecil, and Garrett Counties	Nov. 15–Dec. 24.
Raccoon, opossum (see exception)	Nov. 1–Jan. 31.[57]
Exception: In Harford County	Nov. 1–Nov. 30.
Woodcock	Nov. 10–Dec. 10[58]
Dove (see exception)	Sept. 1–Sept. 30.[58] Nov. 15–Dec. 15.[58]
Exception: In Allegany, Cecil, and Garrett Counties	Nov. 15–Dec. 15[58]
Duck, goose (except Ross's goose, cackling goose, and snow geese), brant, and coot	Nov. 16–Dec. 15.[58]
Wilson's snipe or jacksnipe	Nov. 1–Jan. 15.[58]
Rails and gallinules, other than coot	Sept. 1–Sept. 30.[58]

No open season: Deer (except as above), elk; Hungarian partridges, reedbirds, swans, Ross's and cackling geese, snow geese, wood duck, eider ducks, auks, bitterns, sand-hill cranes, gannets, grebes, gulls, herons, jaegers, loons, murrers, peterls, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game, $15.50 (fee, $5.50 for State license if applicant owns real estate in Maryland assessed at $500; $1.50 for county license in county where such real estate is located); fish, $5.50. Resident: Game, State, $5.25; county, $1.25; fish, $1.25. Special license for fishing in Deep Creek Lake, Garrett County; resident of county, or person owning property within quarter of a mile of high-water mark of lake may fish in Deep Creek Lake without license; resident of State, nonresident of county, $2.75; nonresident of State, $5.25. Issued by clerks of circuit court of counties—in Baltimore City by clerk, court of common pleas. Permanent resident of Indianhead Government reservation may obtain a resident hunting license for Charles County. Hunting license not issued to persons under 14 without written request of parent or guardian. Angling license required above tidewater of person over 16. License not required of land-owners, tenants, and members of their families fishing from shore of own property. Hunting licensee required to wear tag displayed on middle of back and fishing-license button must be worn in plain view. Owners, tenants, and their children may hunt on own land during open season without license, except that waterfowl may not be hunted on waters of State without license. Local licenses issued to residents of Cecil and Harford Counties are valid for waterfowl hunting on Susquehanna Flats

Sinkbox, sneak boat, blind, pusher: Sinkbox, $20.75; sneak boat, $5.75; issued by clerks circuit court of county of which applicant is a resident; booby, brush, or stake blind, $5.50 (not issued except to resident of State or nonresident owner of land bordering on Potomac River or nonresident owner of land bordering on any waters of the State that is assessed at $500 on tax books of Maryland); pushers, $2.50; issued by clerks of circuit court of counties.

Susquehanna Flats:[56] Sinkbox, $20.75; sneak boat, $5.75; issued by clerks of circuit court in Cecil and Harford Counties.

Bag limits and possession: One deer a season; 1 wild turkey a day, 4 a season, 2 in all of English or Mongolian pheasants and ruffed grouse a day, 6 a season; 6 rabbits or hares, 10 squirrels, 10 quail (partridges), 4 woodcock, 25 doves, 20 jacksnipe, 25 coots, 25 in all of rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, 15 ducks, 4 geese, including brant, a day. Possession of waterfowl permitted during first 10 days of close season. Not more than 30 ducks and 8 geese, including brant, may be possessed at any one time.

Interstate transportation: Export of all protected game (except waterfowl) prohibited; provided, a licensed hunter may take out under his license as personal baggage a quantity equal to two days' bag limit of game; provided further, no person may take or ship out more than 30 ducks and 8 geese, including brant, in any one calendar week. Waterfowl must be shipped open to view and tagged.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of quail, ruffed grouse, wild turkeys, or introduced pheasants (whether taken within or coming from without State), and doves and all other migratory game birds prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live-goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been scattered to attract them.

MASSACHUSETTS

Open seasons:[59]	*Dates inclusive*
Deer (from half an hour before sunrise, first Monday in December to half an hour after sunset the following Saturday, inclusive) (see exceptions)	Dec. 7–Dec. 12.
Exceptions: In Berkshire, Franklin, Hampshire, and Hampden Counties	Dec. 7–Dec. 19.
In Nantucket County	No open season.
Hare (known as varying or Canada hare or snowshoe or white rabbit) or rabbit (see exceptions)	Oct. 20–Feb. 15.
Exceptions: In Nantucket County	Oct. 20–Feb. 29.
European hares, in Berkshire County	No close season.

---

[56] *Maryland:* A number of local restrictions apply to the hunting of wild fowl, especially on Susquehanna Flats and Patuxent River, information concerning which may be obtained from the State game warden, Munsey Building, Baltimore.

[57] Unlawful to trap raccoon or opossum with steel trap or similar device, or, without consent of owner, to cut trees in hunting them.

[58] Season on migratory game birds opens at 12 o'clock noon.

[59] *Massachusetts:* Governor may suspend open seasons during extreme drought.

Open seasons—Continued.	*Dates inclusive*
Gray squirrel, quail, male pheasant,[60] ruffed grouse (see exceptions)	Oct. 20-Nov. 20.
Exceptions: Quail in Essex, Hampden, Hampshire, Middlesex, Nantucket, Norfolk, and Worcester Counties	No open season
Pheasant, in Dukes County	No open season
Woodcock	Oct. 20-Nov. 19.[61]
Duck, goose (except Ross's goose, cackling goose, and snow geese), brant, coot	Nov. 1-Nov. 30.[61]
Wilson's snipe or jacksnipe	Oct. 1-Dec. 31.[61]
Rail and gallinule, other than coot	Oct. 1-Dec. 15.[61]

No open season: Moose, doves, prairie chickens, Hungarian partridges, pheasant hens (English, golden, Mongolian),[60] heath hens, Ross's and cackling geese, snow geese, swans, wood duck, eider ducks, auks, bitterns, sand-hill and whooping cranes, fulmars, gannets, guillemots, gulls, herons, jaegers, loons, murres, terns, and all shore birds (except woodcock, and Wilson's snipe or jacksnipe).

Hunting and fishing licenses:[62] (Sporting licenses): Nonresident citizen, $10.25; fishing only, $3.25. Nonresident residing in a State affording similar privileges to residents of Massachusetts, who owns real estate assessed at not less than $500, or who is a member of a hunting or fishing club or association incorporated prior to 1907, or who is a guest on written invitation of an incorporated club or association for hunting foxes, fee $3.25. If applicant's State of residence charges nonresidents a higher fee, then such applicant shall be charged an equal fee.

Resident citizen, $2.75; no charge to persons over 70. Alien, $15.25 (applicant must have resided in State 10 days and own real estate therein to the assessed value of $500). License required for permanent gunning stand or blind, fee $2.75. Duplicate of lost or destroyed license, fee, 50 cents. Issued by director of fisheries and game, and city and town clerks. Licenses must be carried on person, and exhibited on demand of officers, landowners, and agents.

Sporting licenses not issued to minors under 15, and those under 18 must apply in writing and furnish written consent of parent or guardian. A license (fee, $1.25) to trap quadrupeds may be issued to a minor between ages of 15 and 18 upon written consent of parent or guardian. Special fishing license for minors between 15 and 18, $1.25.

Licensee required to report number of each species of birds and animals taken by him before obtaining new license.

Resident may hunt during open season without a license on land owned or leased on which he is actually domiciled and which is used exclusively for agricultural purposes, and not for club, shooting, or fishing purposes, and may fish in inland waters bordering such lands. License to fish not required of minors under 15.

Bag limits and possession: One deer a season; 2 hares and 5 rabbits a day or in possession; 5 gray squirrels a day, 15 a season; 4 quail a day, 20 a season; 2 pheasants a day, 6 a season; 3 ruffed grouse a day, 15 a season; 4 woodcock, 15 ducks, 4 geese, including brant, 20 Wilson's snipe, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day. Resident may possess for own use during close season game legally taken or acquired by him, but migratory game birds may only be possessed 10 days after close of season.

Not more than 30 ducks and 8 geese, including brant, may be possessed at any one time.

Interstate transporation: A nonresident under his license may take out fish and game lawfully taken if carried open to view. A resident may export all game lawfully killed, but not more than two days' bag limit of migratory birds may be exported in any one calendar week.

Game taken outside of State and legally exported may be possessed for personal use.

Sale: Sale of all game prohibited; provided, deer, moose, caribou, and elk lawfully killed and coming from without State, under warden's tag, may be sold under license at any time. Hares or rabbits lawfully obtained and coming from a State where their sale is not prohibited may be sold under license.

Miscellaneous: Deer may be taken with a shotgun and bow and arrow only. Unlawful to hunt or kill game with rifle or revolver during open season for deer, or to have dog in woods. Unlawful to use grain for baiting wild birds.

Unlawful to import or liberate any live game birds or animals except under permit.

Hunting prohibited on State and paved highways and within 50 yards thereof.

Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Training of hunting dogs prohibited between April 1 and September 1.

MICHIGAN

Open seasons:[63]	*Dates inclusive*
Deer (male, with horns not less than 3 inches above skull), in Upper Peninsula, and in Alcona, Alpena, Cheboygan, Crawford, Grand Traverse, Iosco, Kalkaska, Manistee, Missaukee, Montmorency, Ogemaw, Oscoda, Otsego, Presque Isle, Roscommon, and Wexford Counties	Nov. 15-Nov. 30.
In rest of State	No open season.
Bear	Nov. 15-Nov. 30.
Rabbit, varying hare (snowshoe or jackrabbit):	
In Upper Peninsula	Oct. 1-Jan. 31.
In Lower Peninsula	Oct. 15-Jan. 31.
Squirrel (fox, gray, and black):	
In Upper Peninsula	Oct. 1-Oct. 10.
In Lower Peninsula	Oct. 15-Oct. 24.
Male ringneck pheasant, ruffed grouse, woodcock:	
In Upper Peninsula (see exception)	Oct. 1-Oct. 12.
Exception: Ruffed grouse	No open season.
In Lower Peninsula	Oct. 15-Oct. 26.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 1-Oct. 31.[64]
Wilson's snipe or jacksnipe	Oct. 1-Dec. 15.[64]
Rails and gallinules, other than coot	Oct. 1-Nov. 30.[64]

No open season: Elk, moose, caribou, doves, quail, Canada or spruce grouse, hen pheasants, Hungarian partridges, wild turkeys, Ross's and cackling geese, swans, wood duck, eider ducks, auks, bitterns, sandhill and whooping cranes, gannets, grebes, gulls, herons, jaegers, loons, murres, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Deer and bear, $50; small game, $10; fish, general, $5; angling, $3. Fishing license not required of person under 18. Resident: Deer and bear, $2.50; small game, $1.25; trout, $1; camping party, $3 (1 buck deer by camping party of four or more). Issued by county clerks, director, or deputy. Hunting license issued to persons under 17 and over 12 on application of parent or guardian, who must accompany such minors when hunting. License button must be displayed on outer garment. Residents and minor children may hunt without license, during open season, small game on own inclosed land on which they reside. Unlawful to hunt on posted farm lands without consent of owner or person in possession.

---

[60] Commission may open season on pheasants.

[61] Season on migratory game birds opens at 12 o'clock noon.

[62] License required to fish in inland waters.

[63] *Michigan:* Director upon approval of conservation commission may shorten or close the season and otherwies restrict the taking of any species of game for a period of not to exceed five years in any county. Such orders may be modified or rescinded when conditions warrant.

[64] Season on migratory game birds opens at 12 o'clock noon.

Bag limits and possession: One deer, 1 bear, a season; 5 fox squirrels a day, 10 in possession, 15 a season; 5 rabbits a day, 5 in possession in Upper Peninsula, 10 in possession in Lower Peninsula, 50 a season; 5 each of ruffed grouse or prairie chickens a day, 10 each a season or in possession; 2 Chinese or ring-necked pheasants a day, 4 a season or in possession; 15 ducks a day, 30 in possession, 100 a season; 4 geese, including brant, a day, 10 a season; but not more than 5 in the aggregate of both in possession; 4 woodcock a day, 8 in possession, 16 a season; 10 Wilson's snipe a day, 20 in possession, 50 a season; 10 coots a day, 20 in possession, 50 a season; 10 rails and gallinules combined a day, 20 in possession, 50 a season. Deer and bear lawfully killed may be possessed during first 30 days of close season, and game birds and other game animals during first 10 days thereof. Camping party of not less than four licensed hunters may, under permit (fee, $3), kill 1 deer for camp purposes.

Interstate transportation: Export prohibited of all protected game. *Exceptions:* (1) Deer and bear may be transported outside of State to reach a point within State. (2) Nonresident licensee may take out as hand baggage, open to view, possession limit of game birds, rabbits, and squirrels, and may ship 1 deer and 1 bear lawfully killed by himself when deer license tag and seal are attached. (3) Heads and skins of deer and bear, green or mounted, lawfully taken, may be exported under permit.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale prohibited of all protected game, except rabbits lawfully killed and imported within 15 days, provided heads and skins of deer and bear green or mounted, lawfully taken, may be sold or transported under permit.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

MINNESOTA

Open seasons: [65]	*Dates inclusive*
Deer (season closed in odd, open in even years)	Nov. 15–Nov. 25.[66]
Bear, even years	Nov. 15–Nov. 25.
Odd years	Apr. 15–May 15.
Varying hare or snowshoe rabbit	No close season.
Squirrel (gray or fox)	Oct. 15–Jan. 1.[67]
Quail	Oct. 15–Nov. 20.
Male ring-necked pheasant (season closed in odd, open in even years)	Oct. 15–Oct. 25.
Prairie chicken or pinnated grouse, white-breasted or sharp-tailed grouse (season closed in even, open in odd years)	Sept. 16–Oct. 1.
Mourning dove	Sept. 16–Oct. 1.[68]
Duck (except wood duck), goose, (except Ross's goose and cackling goose), brant, coot	Oct. 1–Oct. 31.[68]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[68]
Rail and gallinule, other than coot	Sept. 16–Nov. 30.[68]

No open season: Elk, moose, caribou, black squirrels, ruffled grouse, Canada spruce grouse, ring-necked pheasant hens, Hungarian gray partridges, wild turkeys, upland plover, woodcock, black-bellied and golden plovers, Ross's and cackling geese, swans, wood duck, eider ducks, auks, bitterns, little brown, sand-hill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident or alien: Big game, $50.25 (includes 25 cents for metal-locking deer seal); small game, $25. Fishing license, $3 (not required of persons under 16 years of age if parent or guardian is licensed). Issued by commissioner, county auditors, and agents. Resident: Big-game animals, $2.25 (includes 25 cents for metal-locking deer seal); small game, $1; fish, 50 cents (family license to fish, $1—includes identification card for each member of family 18 years of age or over); fishing license not required of resident under 18; fish house, $1—Issued by county auditor. Hunting license not required of persons under 18 and owners, lessees, or members of their immediate families may hunt birds or animals (except deer or moose) during open season on own or leased land occupied by them as permanent residence without license.

Any person taking protected wild animals or birds, with or without license, must report to State game commissioner, on or before Jan. 31, number of each kind of game killed during preceding calendar year. Unlawful to enter growing grainfields for purpose of hunting without permission of owner.

Bag limits and possession: One deer a season; 7 squirrels a day, 14 in possession; 4 geese including brant, 12 ducks, and 15 in all of coots, gallinules, Wilson's snipe or jacksnipe, and rails a day, 36 in all in possession, of which not more than 5 may be geese including brant, and 30 may be ducks; 120 ducks a season; 10 quail a day, 15 in possession, 30 a season; mourning doves, 9 a day, 30 in possession, 30 a season; 3 ring-necked pheasants a day, 12 in possession, 15 a season, but not more than 15 game birds in all in one day. Possession permitted during first 5 days of close season. Under permit or tags deer may be possessed to February 28, migratory birds for 10 days after close of season, but no game birds may be possessed after January 10.

Interstate transportation: Export of all protected game prohibited, except that nonresident licensee may ship home in open season under his license coupons 1 deer and 25 birds lawfully taken by himself, but not more than the possession limit of any one species a season; not more than 5 geese, including brant, may be exported by one licensee. Deer hides for tanning and heads for mounting may be exported when tagged with license coupons (deer season closed in odd years).

Game taken outside of State and legally exported may be possessed at any time under a retaining tag, obtained from State game and fish commissioner, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Sale: Sale of all protected game prohibited; provided, hides of deer legally killed may be sold.

Miscellaneous: Unlawful to carry gun in motor vehicle unless unloaded in both barrel and magazine and taken apart or contained in a case. Unlawful to keep game in cold storage.

Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

MISSISSIPPI [69]

Open seasons:	*Dates inclusive*
Deer (male)	Nov. 20–Dec. 31.
Squirrel	Oct. 1–Dec. 31.
Hare, rabbit	No close season.
Quail or partridge (bobwhite)	Nov. 20–Jan. 31.
Wild-turkey gobblers	Apr. 1–Apr. 15.

---

[65] *Minnesota:* Seasons subject to change by regulations. All hunting prohibited within 3 miles of corporate limits of Duluth, Minneapolis, and St. Paul.

[66] Deer may be taken with bow and arrow.

[67] Squirrels protected within corporate limits of any city or village, or within a quarter of a mile thereof.

[68] Season on migratory game birds opens at 12 o'clock noon.

[69] *Mississippi:* Board of supervisors of any county may by regulation shorten or close seasons, reduce bag limits, or extend other protection to game within the provisions of the law.

Open seasons—Continued.	*Dates inclusive*
Dove	Sept. 1-Sept. 30.[70] Nov. 20-Jan. 31.[70]
Woodcock	Dec. 1-Dec. 31.[70]
Waterfowl (except Ross's goose and cackling goose), coot	Nov. 16-Dec. 15.[70]
Wilson's snipe or jacksnipe, poule d'eau	Nov. 1-Jan. 15.[70]
Rail and gallinule, other than coot	Sept. 1-Nov. 30.[70]

No open season: Does and spotted fawns, bear, turkey hens, ruffled grouse, pheasants, western quail, Ross's and cackling geese, swans, wood duck, bitterns, sand-hill cranes, grebes, gulls, herons, loons, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game, State, $15; county, $10; fish, $2 (county). Resident: Game, State, $3; county, $1 to $3 in discretion of board of supervisors. Issued by sheriff. License not required for hunting rabbits nor of persons under 16 or over 70. Landowners may hunt during open season on own lands without license. Written permission of owner or agent required to hunt, trap, or fish on posted lands of another.

Bag limits and possession: One deer a day, 3 a season; 15 squirrels a day; 2 turkey gobblers a season; 15 quail a day; 15 ducks, 4 geese, including brant, 20 Wilson's snipe, 4 woodcock, 25 doves, 25 coots, 25 sora, but not more than 25 in all of rails (other than sora), coots, and gallinules, and not more than 15 of any one species of rails (other than sora) and gallinules a day. Nonresident limited to not more than 25 migratory game birds of all kinds in one day of which not more than 15 may be ducks, and not more than 4 may be geese including brant. Possession of migratory birds permitted during first 10 days of close season, but not more than 30 ducks and 8 geese, including brant, may be possessed at any one time.

Interstate transportation: Export of all protected game prohibited, except that a nonresident licensee may take out in personal possession one day's limit of game birds he has lawfully killed.

Game taken outside of State and legally exported may be possessed only during open season in State but migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Sale: Sale of all protected game (except rabbits) prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

MISSOURI

Open seasons:	*Dates inclusive*
Deer (male, with four or more points to one antler), 3 days only	Oct. 22, 23, 24.[71]
Squirrel	June 1-Nov. 30.
Wild turkey	Dec. 1-Dec. 31.
Quail (bobwhite partridge) (see exception)	Nov. 10-Dec. 31.
Exception: In Harrison, Johnson, Daviess, Cass, Andrew, and Atchison Counties	No open season.
Dove	Sept. 1-Dec. 15.[72]
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 20-Nov. 19.[72]
Woodcock	Nov. 10-Dec. 19.[72]
Wilson's snipe	Oct. 1-Dec. 31.[72]
Rail and gallinule, other than coot	Sept. 15-Nov. 30.[72]

No open season: Ruffed grouse (pheasants), prairie chickens (pinnated grouse), imported pheasants, other introduced game birds, Ross's and cackling geese, swans, wood duck, bitterns, little brown, sand hill, and whooping cranes, grebes, gulls, herons, egrets, loons, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident or alien: Game and fish, $10; fish, $3 (season); 15-day license, $1. Issued by commissioner or county clerk. Resident: Game and fish, State, $2.50; county, $1, good in county of residence or adjoining county; fish (State), $1. Issued by county clerk or license collector. Fishing license not required in county of residence nor of women or minors who are citizens. Owners and tenants of agricultural lands and members of family under 21 residing thereon may hunt without license during open season on own or leased land when used for agricultural purposes only, but may not transport or ship game or fur animals therefrom without a license. Hunting on land of another prohibited without his consent.

Special deer tag required in addition to hunting license, resident, $1.50; nonresident, $50. Not required of resident landowner hunting on own premises.

Bag limits and possession: One deer, 1 turkey a season; 10 squirrels, 10 quails, 10 doves, 15 ducks, 4 geese, including brant, 4 woodcock, 15 Wilson's snipe a day; 15 rails, 15 coots, 15 gallinules, but not more than 25 in all a day or in possession; or 1 turkey, 15 quail, 15 doves, 8 geese, including brant, 25 of any other species of birds in possession. Possession of migratory game birds permitted during first 10 days of close season, other game during first 5 days thereof.

State hunting license required to possess game. Tagged carcass of legally killed deer may be possessed until February 5.

Interstate transportation: Export of all protected game prohibited, except that not more than two days' limit of game may be exported under resident or nonresident license if carried openly as baggage or express or in owner's possession and accompanied by him.

Game taken outside of State and legally exported may be possessed in like numbers and manner as game taken in State, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Sale: Sale of all protected game prohibited.

Miscellaneous: Unlawful to store or serve game in commercial establishments.

Federal regulations do not permit the use of more than 10 live goose decoys at any one gunning stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area that has been baited with salt, grain, or other food to attract them.

MONTANA

Open seasons:[73]	*Dates inclusive*
Deer (male with horns not less than 4 inches long), (see exceptions)	Oct. 15-Nov. 15.
Exceptions: In Granite, Missoula, and Powell Counties (males only)	Oct. 25-Nov. 25.
In Flathead, Lake, Lincoln, Mineral, and Sanders Counties, and in part of Ravalli County (either sex)	Oct. 25-Nov. 25.
In part of Ravalli County (either sex)	Sept. 20-Oct. 20.
In part of Glacier County (either sex)	Oct. 15-Nov. 15.

---

[70] Season on migratory game birds opens at 12 o'clock noon.

[71] Deer may not be killed except through use of a gun loaded with one all-lead, lead alloy, or soft-nosed or expanding bullet, except by landowner hunting on own premises. Dogs may not be used in hunting deer.

[72] Season on migratory game birds opens at 12 oclock noon.

[73] *Montana.* Commission may close season in any district on any species of game threatened with undue depletion from any cause, or reopen such districts, may advance the date of open season on sage grouse in any county, and may specify open seasons and bag limits, locally, on upland game birds on which season is closed.

Open seasons—Continued.	*Dates inclusive*
Deer—Continued.	
Exceptions—Continued.	
In Blaine, Carbon, Carter, Custer, Daniels, Dawson, Fergus, Garfield, Liberty, McCone, Musselshell, Petroleum, Phillips, Powder River, Prairie, Richland, Roosevelt, Rosebud, Sheridan, Teton, Toole, Treasure, Valley, Yellowstone, and parts of Big Horn, Gallatin, Glacier, and Pondera Counties	No open season.
Elk,[74] in Flathead, Glacier, Madison, Petroleum, Pondera, and parts of Gallatin, Missoula, and Powell Counties	Oct. 15–Nov. 15.
In part of Lewis and Clark County	Nov. 1–Nov. 15.
In part of Lewis and Clark and Teton Counties	Oct. 15–Dec. 1.
In Park County	Oct. 15–Dec. 20.
In part of Ravalli County	Sept. 20–Oct. 20.
In rest of State	No open season.
Bear (unlawful to trap)	No close season.
Pheasant, partridge, prairie chicken, fool hen, sage hen, grouse	Sept. 16–Sept. 25.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 1–Oct. 31.[75]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[75]
Rail and gallinule, other than coot	Sept. 16–Nov. 30.[75]

No open season: Mountain sheep, mountain goats (except as opened locally by commission); elk (except as above), does and fawns, moose, caribou, antelope, bison or buffalo; quail, introduced pheasants, Hungarian partridges, ptarmigan, wild turkeys,[73] doves, swans, Ross's and cackling geese, wood duck, bitterns, little brown, sand-hill, and whooping cranes, grebes, gulls, herons, loons, band-tailed pigeons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses:[76] Resident—class A, game birds and fishing, $2; class AA, game animals, $1 (issued only to holder of class A license); class AAA, "sportsman's license," general hunting and fishing, $5. Nonresident—class B, fishing, $3.50; class B–1, game birds, $10; class B–2, general hunting and fishing, $30. Alien—class C, fishing, $10; class C–1, game birds, $30; class C–2, game animals, $50. Guide (resident citizen only), $10. Taxidermist, $15. Issued by warden, deputies, justices of peace, and authorized agents. Game bird or fishing license not required of minors under 15. Alien not holding a class C–2 license must obtain from warden a license to own or possess firearms (fee $25).

Bag limits and possession: One deer, 1 elk, a season; 5 in all of grouse, partridges, prairie chickens, fool hens, pheasants, and sage hens a day or in possession; 15 ducks, 4 geese, including brant, 20 Wilson's snipe, 25 coots, 25 sora, 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day. Migratory game birds legally taken may be possessed during open season and first ten days of close season, but not more than 30 ducks and 8 geese, including brant, may be possessed at any one time.

Interstate transportation: Export of all protected game prohibited; provided, game lawfully killed may be exported by a resident under shipping permit (fee, 50 cents) from State warden; a nonresident may export under his license game he has lawfully taken; total shipments under permits or one license may not exceed season's bag limit and not more than two days' limit of migratory birds may be exported in any one calendar week; packages must be labeled to show contents.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of bears and all protected game prohibited; provided, merchant or hotel or restaurant keeper may sell game, except migratory birds, killed outside the State. Under permit, mounted specimens or hides or heads of game animals or birds lawfully taken may be sold.

Miscellaneous: Elk and deer must be tagged by licensee immediately upon being killed, with tag accompanying license, and killing must be reported on or before Jan. 1.

Federal regulations do not permit the use of more than 10 live goose decoys at any one gunning stand or blind in hunting wild geese.

NEBRASKA

Open season:[77]	*Dates inclusive*
Squirrel	Oct. 1–Dec. 31.
Rabbit	No close season.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 20–Nov. 19.[78]
Wilson's snipe or jacksnipe	Oct. 1–Nov. 1.[78]
Rails and gallinules, other than coot	Oct. 1–Nov. 30.

No open season: Buffalo, deer, elk, antelope, mountain goats, mountain sheep, quail, partridges, sage hens, introduced pheasants[77] or partridges, prairie chickens,[77] grouse[77]; ptarmigan, introduced game birds, wild turkeys, doves, woodcock, Ross's and cackling geese, swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game, $10.10; fish, $2.10. Alien: Fish, $5.10. Resident, $1.10. Issued by game, forestation, and parks commission and authorized vendors. Licenses required of all persons over 16. Issuance of hunting license to person known to be physically or mentally unfit to carry or use firearms prohibited. Consent of owner required to hunt on private premises. Alien not permitted to hunt, or to own or possess firearms.

Bag limits and possession: Ten squirrels a day, or in possession; 5 pheasants a day, or in possession; 20 ducks and coots a day, 40 in possession, but not more than 15 ducks a day or 30 in possession; 4 geese and brant combined a day or in possession; 15 Wilson's snipe a day or in possession; 15 rails and 15 gallinules a day or in possession, but not more than 25 in all of rails and gallinules a day; 40 in all of game birds in possession, but not more than 30 ducks and 5 geese including brant, may be possessed at any one time. Possession permitted during first 10 days of close season.

Interstate transportation: Game may be transported by express or baggage during the open season when tagged as required by commission, and shipper's statement that the game is not for sale or profit, and was not taken contrary to law, is furnished commission and a copy attached to shipment; package must be labeled with consignor's license number and kind of game, consigned to shipper, and accompanied by him; shipment must not contain more than 40 game birds or the possession bag limit on any species. Not more than two days' limit of migratory birds may be exported in any one calendar week.

---

[73] Footnote 73 on second column p. 27.

[74] Commission may declare open seasons on and prescribe regulations governing hunting of elk in any portion of closed area, and on five days' notice close season on elk in Park and Teton Counties, and in part of Lewis and Clark County, and may shorten the season in Ravalli and Park Counties.

[75] Season on migratory game birds opens at 12 o'clock noon.

[76] Resident licenses issued to officers of the Forest Service and of the Bureau of Biological Survey, members of United States Department of Agriculture, and to officers and members of the United States Army, Navy, or Marine Corps.

[77] *Nebraska:* Game, forestation, and parks commission, upon written request from any county board, may open season on pheasants, prairie chickens, and grouse in such county for 15 days or less between Sept. 16 and Dec. 31. Owner or occupant of farmlands may, under permit, kill pheasants damaging or destroying crops.

[78] Season on migratory game birds opens at 12 o'clock noon.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of all protected game prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

NEVADA

Open seasons:[79]	*Dates inclusive*
Deer (male with branched horns)	Oct. 1–Oct. 15.
Quail, pheasant	Nov. 1–Nov. 5.
Sage hen	Aug. 8–Aug. 9.
Bear, squirrel	No close season.
Cottontail rabbit, mountain hare	Nov. 1–Dec. 31.
Dove	Sept. 1–Dec. 15.[80]
Duck, goose (except Ross's goose and cackling goose), brant, coot	Nov. 16–Dec. 15.[80]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[80]
Rail and gallinule, other than coot	Sept. 1–Nov. 30.[80]

No open season: Mountain sheep, mountain goats, antelope except as permitted by commission; elk, does, fawns, and spike bucks; Ross's and cackling geese, swans, wood duck, bitterns, little brown and sand-hill cranes, grebes, gulls, herons, loons, murres, band-tailed pigeons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident citizen:[81] Game, $10; fish, $3. Alien, fish, $7.50. Resident citizen: Game, $2.50; fish, $1.50. Deer tags, fee $1, required of holders of licenses to hunt deer. Issued by county clerks and wardens. Aliens prohibited from hunting. No license required of boys and girls under 14.

Bag limits and possession: One deer a season, 5 cottontail rabbits, 2 mountain hares, 10 valley quail, 5 mountain quail, 3 partridges, 3 grouse, 3 pheasants, 5 priarie chickens, 10 sage hens, 15 ducks, 4 geese, including brant, 10 snipe, and 25 doves a day or in possession, except that 8 in the aggregate of geese and brant, but not more than 5 geese or 5 brant, may be possessed at any one time; 25 coots, 25 sora, and 25 in all of the other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day. One day's limit of game lawfully taken may be possessed during first 60 days of close season, under permit, except migratory game birds may not be possessed for more than 10 days after close of season. Deer lawfully taken in another State and exported may be personally brought into State by the taker during close season.

Interstate transportation: Export of all protected game prohibited, except holder of a deer-license tag may export a deer legally killed thereunder upon the tag being countersigned by a regular deputy, commissioner, or officer authorized to administer oaths. Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of deer meat and of all other protected game is prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live-goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

NEW HAMPSHIRE

Open seasons:[82]	*Dates inclusive*
Deer, in Coos County (except in towns of Dalton, Whitefield, and Carroll)	Oct. 15–Nov. 30.
In Carroll County	Nov. 15–Dec. 15.
In Cheshire County	Dec. 1–Dec. 15.
In Grafton County and in towns of Dalton, Whitefield, and Carroll in Coos County	Nov. 1–Dec. 15.
In Rockingham County	Dec. 15–Jan. 1.
In rest of State	Dec. 1–Dec. 31.
Hare, rabbit	Oct. 1–Feb. 28.
Partridge, ruffed grouse	Oct. 1–Nov. 30.
Pheasant (male) in Hillsborough, Merrimack, Rockingham, and Strafford Counties only	Nov. 1–Nov. 6.
Quail	Oct. 15–Nov. 15.
Woodcock	Oct. 1–Oct. 31.
Duck, goose, (except Ross's goose, cackling goose, and snow geese), brant coot	Oct. 1–Oct. 31.[83]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[83]
Rail, other than coot and gallinule	Sept. 1–Nov. 30.[83]
Gallinule	Sept. 16–Nov. 30.[83]

No open season: Elk, moose, caribou, doves, pheasants (except as above), European partridges; gray squirrels (1935);[82] Ross's and cackling geese, snow geese, swans, wood duck, eider ducks, auks, bitterns, sand-hill cranes; gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game and fish, $15.15; fish, $3.15. Resident: Game and fish, $2. Resident soldiers and sailors more than 70 years of age may obtain license free on application to fish and game commissioner. Fishing licenses not required of children under 16 or of blind persons. Issued by commissioner or his agent in each town, who with few exceptions is the town clerk. Children under 16 may hunt without license when accompanied by licensed parent or guardian. Resident owner of farm lands and his minor children may hunt during open season, on own land without license. Guide: Nonresident, $20; resident, $1. Issued by commissioner.

Bag limits and possession: One deer a season; 5 hares a day; 5 ruffed grouse a day, 25 a season; 5 quail a day; 2 pheasants a day, 5 a season; 4 woodcock a day, 25 a season; 15 ducks, 4 geese, including brant, 20 Wilson's snipe, 25 coots, 25 sora, and 25 in all of other rails and gallinules but not more than 15 of any one species of rails (other than sora) and gallinules a day. Not more than 30 ducks and 8 geese, including brant, may be possessed at any one time. Deer may be possessed for a reasonable time after close of open season.

Interstate transportation: Export of all protected game prohibited, provided head, hide, feet, or fur of game quadrupeds, and plumage or skins of game birds (except migratory birds) legally taken and possessed may be transported in State without being marked, but under Federal laws all interstate shipments must be marked as to contents. Nonresident may take or ship out of State, under his hunting license, one day's limit of game birds, and under license coupon, one deer. Shipments by common carrier must have attached tag showing number and kind of game, names of consignor and consignee, and point of shipment and destination, and shipment or transportation of game must be indorsed on back of shipper's license.

---

[79] *Nevada:* Fish and game commission fixes open seasons on deer with branched horns and upland game birds, and county commissioners may shorten or close season entirely on deer, upland game, or migratory game birds.

[80] Season on migratory game birds opens at 12 o'clock noon.

[81] Citizen of any State must pay same fee for hunting or fishing license as charged nonresidents by his State of residence.

[82] *New Hampshire:* Governor and council may suspend open season in time of excessive drought or emergency. Owner of farm lands may take at any time gray squirrels doing actual damage to his crops.

[83] Season on migratory game birds opens at 12 o'clock noon.

Deer must be tagged with license coupon before being moved.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of all migratory birds prohibited. Sale for food purposes prohibited of the dead bodies of birds belonging to a family any species or subspecies of which is native to and protected by State; provided deer may be sold during open season for consumption as food only within State.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

NEW JERSEY

Open seasons:	*Dates inclusive*
Deer [84] (male, with horns not less than 3 inches long)	Dec. 17–Dec. 21.
Raccoon	Oct. 1–Dec. 15.
Rabbit,[85] gray,[85] fox, and black squirrels, quail, ruffed grouse (partridge), prairie chicken, English or ring-necked pheasant cocks (see exceptions)	Nov. 10–Dec. 15.
Exceptions: Quail in Bergen, Essex, Hudson, Hunterdon, Morris, Passaic, Somerset, Sussex, Union, and Warren Counties	Mar. 15, 1933.
Ruffed grouse in Essex, Hunterdon, Mercer, Middlesex, Monmouth, Somerset, and Union Counties	Mar. 9, 1932.
Duck (except wood duck and eider ducks), goose (except Ross's goose, cackling goose, and snow geese), brant, coot	Nov. 16–Dec. 15.[86]
Wilson's snipe or jacksnipe	Oct. 16–Jan. 15.[86]
Woodcock	Oct. 15–Nov. 14.[86]
Rail and gallinule	Sept. 1–Nov. 30.[86]

No open season: Does and fawns, wild turkeys, English or ring-necked pheasant hens, Hungarian partridges, reedbirds, doves, Ross's and cackling geese, snow geese, swans, wood duck, eider ducks, auks, bitterns, little brown, sandhill, and whooping cranes, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident and alien: Game and fish, $10.50; fish (in fresh waters), $5.50. Resident citizen above age of 14: Game and fish, $1.65; ($3.15 after Jan. 1, 1932); when applied for by parent or legal guardian, in discretion of commission, license may be granted to citizen between ages 10 and 14 to hunt when accompanied by adult holder of a general license: Fee, $1; issued only by commission. Special license to hunt woodcock from Oct. 15 to Nov. 9, fee $2, required in addition to regular hunting license; issued by commission. All other licenses, except as indicated, issued by county, city, or town clerk, salaried warden, or registrar of licenses. Applicant for license must report number of fish, birds, or animals taken by him or her in previous year. Licensee required to wear in a conspicuous place on his outer clothing a license button. Occupant of farm and immediate members of his family residing thereon with him may hunt or fish on such farm during open season without license. Hunting on occupied posted lands of another prohibited.

Alien prohibited from hunting or owning shotgun or rifle unless he is owner of real property in New Jersey to the value of $2,000 above all incumbrances, in which case he may obtain nonresident and alien license.

Bag limits and possession: One deer a year; 2 English or ring-necked pheasant cocks a day, 30 a season; 6 rabbits, 6 gray squirrels, 10 quail, 3 ruffed grouse, 4 woodcock, 20 snipe, 25 sora, 25 coots, and 25 in all of other rails, coots, and gallinules but not more than 15 of any one species of rails (other than sora, marsh hens, and coot) and gallinules a day or in possession; 15 ducks, 4 geese, including brant, a day, but not more than 25 ducks and 8 geese, including brant, may be possessed at any one time. Deer carcasses from another State or a State game preserve may be possessed at any time if properly tagged to show where killed; possession of other game permitted during first 10 days of close season.

Interstate transportation: Export of all protected game (except deer) prohibited, except that a nonresident licensee in one day may carry from State the daily bag limit of game, if open to view, but not more than two days' limit of game may be exported in one calendar week.

Game taken outside of State and legally exported may be possessed at any time, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Sale: Sale of deer, squirrels, and all game birds prohibited; rabbits may be sold during open season and 10 days thereafter; cottontail rabbits, Belgian hares, and jack rabbits legally killed and coming from another State may be sold at any time.

Miscellaneous: Unlawful to use shotgun or rifle holding more than two cartridges or that may be fired more than twice without reloading.

Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

NEW MEXICO

Open seasons: [87]	*Dates inclusive*
Deer (with horns at least 6 inches long), wild turkey, (see exception)	Oct. 20–Oct. 31.
Exception: In McKinley County	No open season.
Bear	Oct. 1–Oct. 31.
Squirrel	Oct. 20–Oct. 31.
Quail (except bobwhite quail), (see exception)	Nov. 10–Dec. 10.
Exception: In McKinley and Otero Counties	No open season.
Prairie chicken	Sept. 1–Sept. 5.
Doves	Sept. 1–Dec. 15.[88]
Duck, goose (except Ross's goose and cackling goose), brant, coot	Nov. 16–Dec. 15.[88]
Wilson's snipe or jacksnipe	Oct. 16–Jan. 15.[88]
Rail and gallinule, other than coot	Sept. 1–Nov. 30.[88]

No open season: Does, Sonoran deer, elk, mountain sheep, mountain goats, antelope, buffalo, grouse, bobwhite quail, pheasants, ptarmigan, sage hens, Ross's goose, cackling goose, swans, wood duck, bitterns, little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, band-tailed pigeons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Big game, bird, and fish, $35.25; big game and bird, $30.25; big game, $25.25: bird, $10.25; fish: General, $3; limited, $1.25. Resident: Big game, bird, and fish, $5; big game and bird, $4.50; bird and fish, $4.50; big game, $3; bird, $2.50; fish: General, $2;

---

[84] *New Jersey:* Wild deer may be taken only with shotgun not smaller than 12 gage, which may not be loaded with a bullet or other missile larger than buckshot. Killing of a deer must be reported to commission or county warden within 48 hours. Owner or lessee of any land, a portion of which is under cultivation, or his authorized agent may kill deer at any time under permit of commission; carcass of deer so killed is the property of the commission, and killing must be reported within 48 hours.

[85] Rabbits and gray squirrels may be killed or trapped on own premises at any time by farmers or fruitgrowers under permit from commission.

[86] Migratory game birds may not be killed at any time on Shark River, or the shores thereof, in Monmouth County. Season on migratory game birds opens at 12 o'clock noon.

[87] *New Mexico:* Commission may close season in any locality on any species, and may prohibit all hunting, in periods of extreme forest-fire danger, at such times and places as may be necessary.

[88] Season on migratory game birds opens at 12 o'clock noon.

limited, $1.25; guide, $5.25; duplicate, $1. Issued by county clerks and deputies designated by State warden. Fishing license not required of children under 14. Alien resident of New Mexico or an adjoining State not permitted to hunt or to own or possess shotgun or rifle in State.

Bag limits and possession: One deer, 1 bear, 5 squirrels, 2 wild turkeys, 10 prairie chickens, 5 grouse, a season or in possession; 12 quail, 5 prairie chickens a day or in possession; 25 doves, 15 ducks, 4 geese, including brant, 20 Wilson's snipe, 25 coots, 25 sora, and 25 in all of other rails and gallinules but not more than 15 of any one species of rails (other than sora) and gallinules a day or in possession, but not more than 15 ducks and 4 geese, including brant, may be possessed at any one time. Possession permitted during open season and first 10 days of close season. Under permit, game, except migratory birds, may be held in storage for first 90 days of close season; migratory birds may be so held for a period of 10 days.

Interstate transportation: Licensee may carry out of State during open season game legally killed, but permits issued by State game warden and license collectors are required to ship game out by common carrier: Fee, $1.25 for 1 deer, 1 bear, and 2 turkeys, and 50 cents for bag limit of other birds and fish.

Game taken outside of State and legally exported, when accompanied by permit or proof of lawful possession, may be possessed under permit obtained from State game and fish warden during open season and first 30 days of close season, but migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Sale: Sale of all protected game taken in State prohibited.

Miscellaneous: Federal regulatons do not permit the use of more than 10 live goose decoys at any one stand or blind in hunting wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

NEW YORK

Open seasons:[59]	*Dates inclusive*
Deer (with horns not less than 3 inches long):	
In Adirondack region[60]	Oct. 26-Nov. 15.
In Ulster, Sullivan, Rensselaer, Delaware, Columbia, Orange, Schoharie, and Dutchess[61] Counties	Nov. 1-Nov. 15.
In Greene County	Nov. 1-Nov. 8.
In rest of State	No open season.
Bear[62]	Oct. 26-Nov. 15.
Varying hare[59]	Oct. 26-Mar. 1.
Cottontail rabbit[59] (see exception)	Oct. 26-Jan. 31.
Exception: In Wayne, Ontario, Orleans, Livingston, Monroe, Niagara, Cayuga, Schuyler, Tompkins, and Onondaga Counties	Oct. 26-Mar. 31.

Open seasons—Continued.	*Dates inclusive*
Squirrel (black, gray)[59] [63]	Oct. 26-Nov. 15.
Quail, in Dutchess, Greene, Orange, Putnam, Rensselaer, Sullivan, and Westchester Counties only	Nov. 15-Nov. 30.
Grouse or partridge	Oct. 26-Nov. 15.
Pheasant, male only	Oct. 26-Oct. 31.
Waterfowl, (except Ross's goose, cackling goose, and snow geese), coot	Oct. 1-Oct. 31.[59]
Wilson's snipe or jacksnipe	Oct. 1-Dec. 31.[59]
Woodcock north of main track of New York Central R. R. from Buffalo to Albany, and Boston and Albany R. R. to Massachusetts line	Oct. 1-Oct. 31.[59]
In rest of State	Oct. 15-Nov. 14.[59]
Rail and gallinule, other than coot	Oct. 1-Nov. 30.[59]

No open season: Elk, moose, caribou, antelope, fawns; fox squirrels; Hungarian or European gray-legged partridges, doves, quail (except as above), Ross's and cackling geese, snow geese, swans, wood duck, eider ducks, auks, bitterns, sand-hill and whooping cranes, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting, trapping, and fishing licenses (combined): Nonresident, $10.50; fish only, $5.50. Resident, $2.25. Special deer license: Nonresident or alien, $10.50; resident, $1.25. Issued by county, city, town, and village clerks where population exceeds 5,000; elsewhere by department and inspectors and protectors; license not issued to minor under 16. Indian resident or member of Six Nations residing on any reservation wholly or partly within State, $2.25. Only licensed Indians residing on a reservation may hunt thereon. Licensee required to wear button. Fishing license not required of women who are bona fide residents of State nor of minors under 16. Owners or lessees and members of immediate families who are citizens actually occupying cultivated farm land may hunt thereon without license during open season. Guide (required in forest reserve counties), license fee, $2; issued by conservation department. Alien not permitted to hunt except under special license from conservation department, or to own or possess shotgun or rifle.

Bag limits: One deer, 1 bear; 3 grouse or partridge a day, 15 a season; 2 male pheasants a day, 6 a season; 4 woodcock a day; 6 varying hares or rabbits, 5 squirrels, 15 ducks, 4 geese, including brant, 25 in all of rails and gallinules, but not more than 15 of any one species of rails and gallinules (except sora) a day; 25 coots, 25 sora, 20 Wilson's snipe or jacksnipe a day.

Local bag limits: Quail, 4 a day, 10 a season, in Dutchess, Greene, Orange, Putnam, Rensselaer, Sullivan, and Westchester Counties.

Possession: Deer, bear, squirrel, grouse, and pheasant during open season and 5 days thereafter; migratory game birds during open season and 10 days thereafter, but not more than 30 ducks and 8 geese, including brant, may be possessed at any one time. Deer and bear properly tagged may be possessed under $1 permit to February 1.

Interstate transportation: Export of game and birds prohibited except that any person may export 1 deer, 1 bear, and one day's limit of other game in one day during open season by means other than parcel post. The taker may export in one day by common carrier, except parcel post, one day's limit when accompanied by permit, which shall show contents of package. Head, hide, and feet of animals and plumage or skin of game birds legally taken may be exported at any time.

Game taken outside of State and legally exported may be brought into State during open season therein and possessed the same as if taken in State. Migratory game birds may be possessed during open season where taken and first 10 days of close season. **Importation permit**, fee $1, obtained from conservation department, required to import game during close season, and then game birds must be accompanied by taker, while quadrupeds bearing New York importation tags may be shipped by common carrier, but not by parcel post. Game other than migratory birds imported under importation permit may be possessed at any time by permit holder for private consumption.

---

[59] *New York:* Commission by order may further restrict taking or possession of game. Open seasons on upland game have been restricted to the following periods or closed as indicated: *Squirrel* (black gray), in Niagara, Orleans, and Yates Counties no open season. *Cottontail rabbit*, in Erie County, Oct. 26-Dec. 31: season opens on migratory game birds at 12 o'clock noon.

[60] The Adirondack region comprises the counties of Clinton, Essex, Franklin, Fulton, Hamilton, Herkimer, Jefferson, Lewis, Oneida, Oswego, Saratoga, St. Lawrence, Warren, and Washington.

[61] In Dutchess County deer may be taken only on own land by owner or lessee, or member of his immediate family, and in Dutchess and Schoharie Counties deer may be taken only by use of shotgun loaded with missile not smaller than buckshot.

[62] Bear unprotected in Clinton, Delaware, Essex, Franklin, Greene, and Ulster Counties, but bear taken in those counties between Nov. 21 and Oct. 15 may be possessed only under license and by marking and tagging as provided for animals taken during open season elsewhere in State.

[63] In corporate limits of city or village squirrels may be taken only under permit of commission.

Sale: Sale of all game, except varying hares and rabbits, prohibited; varying hares and rabbits legally taken in State may be sold during open season, and when brought from without the State may be sold at any time.

Head, hide, and feet of quadrupeds legally taken and possessed may be sold at any time.

Miscellaneous: Hunting prohibited on lands supplying any municipality with water or on public highways, except public highways within forest preserve counties.

Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

NEW YORK—Long Island

Open seasons:	*Dates inclusive*
Squirrel (black, gray), quail, pheasant (male only)	Nov. 1–Dec. 31.
Varying hare	Oct. 26–Mar. 1.
Cottontail rabbit	Oct. 26–Jan. 31.
Grouse	Nov. 1–Dec. 31.
Waterfowl (except Ross's goose, cackling goose, and snow geese), coot, mud hen	Nov. 16–Dec. 15.[89]
Wilson's snipe or jacksnipe	Oct. 16–Jan. 15.[89]
Woodcock	Oct. 15–Nov. 14.[89]
Rail and gallinule, other than coot	Oct. 1–Nov. 30.[89]

No open season: Deer, fox squirrels, doves, Ross's and cackling geese, snow geese, swans, wood duck; eider ducks, auks, bitterns, sand-hill and whooping cranes, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Bag limits and possession: Six quail a day, 40 a season; 4 male pheasants a day, 30 a season. For other bag limits see New York.

Hunting licenses, interstate transportation, sale, miscellaneous (see New York).

NORTH CAROLINA [94]

Open seasons: [94]	*Dates inclusive*
Deer [95] (male)	Sept. 15–Jan. 1.
Bear	Oct. 1–Jan. 15.[96]
Rabbit,[96] quail, wild turkey (see exception)	Nov. 20–Feb. 15.
Exception: Rabbit, in Bertie and Duplin Counties	No close season.
Squirrel	Sept. 1–Dec. 31.
Fox (see exception)	No open season.
Exception: In Ashe, Avery, Iredell, Lenoir, and Watauga Counties	No close season.
Dove	Sept. 1–Sept. 30 [94] [97] Nov. 20–Jan. 31.[94] [97]
Woodcock	Dec. 1–Dec. 31.[94] [97]
Duck, goose (except Ross's goose, cackling goose, snow geese), brant, coot	Nov. 16–Dec. 15 [94] [97]
Wilson's snipe or jacksnipe	Nov. 1–Jan. 15.[94] [97]
Rail (except coot and gallinule)	Sept. 1–Nov. 30 [94] [97]
Gallinule	Nov. 1–Nov. 30.[94] [97]

No open season: Buffalo, elk, does, ruffed grouse, Mongolian, Chinese, or ring-necked pheasants; Ross's goose, cackling goose, snow geese, swans, wood duck, reedbirds, auks, bitterns, gannets, grebes, gulls, herons, jaegers, loons, murres, petrels, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident [98] or alien: Game, $15.25; [98] game and fish, $17.25; game and fur animals, $35.25; fish, $3.10. Nonresident owning land in State may obtain license to hunt thereon, fee, $5.25. Resident (State licenses), game, $3.25; game and fish, $4.50; game and fur animals, $5.25; fish, $2.10. County licenses: Game, $1.25; game and fur animals, $3; fish, $1.10. Hunting guide license, $5. Issued by superior court clerks, wardens, and deputies. Person under 16 who is member of family resident of State may hunt under license of his parent or guardian; nonresident minor child of a resident may procure and use resident hunting license when actually visiting such resident parent. Resident landowner and dependent member of his family under 21 may hunt on own land during open season without license. Lessee of farm for cultivation may hunt thereon without license. License not required for fishing in Atlantic Ocean, the sounds, or other large bodies of water as designated by commission, nor of landowner or member of family under 21 for fishing in waters on his own land, nor of person under 16. Fishing licensee must wear license button. All licenses expire August 1.

Bag limits and possession: Two deer a day or in possession at one time, 4 a season; 2 wild turkeys a day or in possession at one time, 5 a season; 10 squirrels, 10 quail, 4 woodcock, 25 doves, 15 ducks, 4 geese, including brant, 20 Wilson's snipe or jacksnipe, and 25 in all of rails, coots, and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day.

The game allowed in possession at one time is restricted to one day's limit on deer and wild turkeys and two days' limit on other game animals and birds.

Rabbits and squirrels lawfully taken may be possessed during open season and first five days of close season. Other game animals and birds may be possessed during open season and first 10 days of close season.

Interstate transportation: Export of all protected game (except rabbits during open season) prohibited, except that a nonresident licensee, under permit from State warden may export not more than 2 male deer and 2 wild turkeys a season and not more than two days' limit of other game animals and birds a calendar week in any manner except by parcel post, if outside of package in which such game is transported is clearly marked with names and addresses of consignor and consignee and an accurate statement of number and kind of game contained therein.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of all protected game prohibited except rabbits and squirrels during open season.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

---

[94] *North Carolina:* On petition of 25 or more reputable citizens and after public hearing, duly advertised, department of conservation and development may change, close, or reopen seasons within the dates specified for State or any county or district thereof or change the bag limits when special circumstances make such changes desirable and may designate days in each week on which migratory waterfowl may not be taken.

[95] Unlawful to drive deer with dogs in counties west of Person, Orange, Chatham, Moore, Richmond, and Scotland. Upon petition of 50 citizens, department of conservation and development may permit the taking of 1 doe in the bag of 4 in any county where the ratio of does to bucks is such as to injuriously affect their progeny.

[96] Department of conservation and development may change seasons on bears and rabbits.

[97] Season on migratory game birds opens at 12 o'clock noon. Rest days prescribed for waterfowl by certain county laws. Special regulations affecting waterfowl in Currituck, Dare, and Hyde Counties may be obtained from clerks of counties named.

[98] Boards of county commissioners may prescribe additional license fees for nonresidents hunting in their respective counties.

NORTH DAKOTA [illegible]

Open seasons:

	Dates inclusive
Deer (male) (see exception)	Nov. 16-Nov. 25.
Exception: In Bowman, Slope, Billings, Golden Valley, McKenzie south of Township 150, Divide, Burke, Renville, Ward, Bottineau west of Range 76, McHenry, Pierce, Benson, Ramsey, Towner, Cavalier, Nelson, Grand Forks, Walsh, and Pembina Counties	No open season.
Prairie chicken (pinnated grouse), sharp-tailed (white breasted) grouse	Sept. 16-Oct. 16.
Ruffed grouse, in Bottineau, Cavalier, Pembina, and Rolette Counties	Oct. 7-Oct. 16.
Chinese ringneck, Mongolian, and English pheasant (male)	Oct. 15-Nov. 1.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 1-Oct. 31.[1]
Wilson's snipe or jacksnipe	Oct. 1-Dec. 31.[1]

No open season: Elk, moose, antelope, quail, ruffed grouse (except as above), sage hens, Hungarian partridges, doves, woodcock, rail, gallinules, swans, Ross's goose, cackling goose, wood duck, bitterns little brown, sandhill, and whooping cranes, grebes, gulls, herons, loons, shearwaters, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident—Big game (deer), $50; hunting, $25; fishing, $3 (not required of minor under 12). Resident—Big game (deer), $5; hunting, $1.50; fishing, $1 (not required of minor under 18). Taxidermist, $2. Licenses issued by game and fish commissioner, deputy, or county auditor. Alien not permitted to hunt. Person or member of family permanently residing with him may hunt (except for deer), trap, or fish without license during the open season on own lands or lands cultivated by him. Resident license may be issued to settler. Unlawful to enter cultivated or posted lands without consent of owner.

Bag limits and possession: Pinnated grouse (prairie chicken), sharp-tailed grouse, ruffed grouse, 5 of each or all combined a day, but not more than 10 of each or all combined in possession. Four geese a day, including brant, 8 in possession. Ducks, jacksnipe, quail, 15 of each or all combined a day, but not more than 2 days' bag limit of each or all combined in possession; 10 jacksnipe, 12 coot, 3 male pheasant, a day. Resident licensee may, under permit, retain in possession for more than 5 days after close of season not to exceed the possession limits stated above and may ship or carry with him to own home 2 days' bag limit of game lawfully taken.

Interstate transportation: Export of all protected game prohibited, except that resident licensee may, under special permit, ship to any point within or without State other than his own home, 10 protected game birds a season, but not more than 8 wild geese, including brant, or 8 woodcock, may be shipped in any one calendar week. Nonresident licensee may carry with him from State under license tag 2 days' limit of game, if open to view and labeled with his name and address and number of his license. Not more than two days' limit of migratory birds may be exported in any one calendar week.

Game taken outside of State and legally exported may be possessed in like numbers and manner as game taken in State, except that migratory game birds may be possessed under permit from game and fish commissioner first 10 days of close season.

Sale: Sale of all protected game prohibited, except that hides, heads, and trophies of big game lawfully taken may be sold at any time.

Miscellaneous: The training or running of any dogs known as "bird dogs," including pointers, setters, and droppers, or allowing them to run loose in fields or on land where game birds may be found is prohibited between April 1 and November 1.

Resident owner may handle retrievers and spaniels on own land, or, with permission of owner, on lands of another, between August 1 and March 1, inclusive.

Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

OHIO

Open seasons:

	Date inclusive
Hare, rabbit	Nov. 15-Jan. 1.[2]
Squirrel	Sept. 15-Oct. 1.
Cock pheasant (introduced), Hungarian partridge	Nov. 15-Nov. 25.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 16-Nov. 15.[3]
Woodcock	Oct. 15-Nov. 14.[3]
Wilson's snipe or jacksnipe	Oct. 1-Dec. 31.[3]
Rail, other than coot and gallinule	Nov. 1-Nov. 30.[3]
Gallinule	Oct. 1-Nov. 30.[3]

No open season: Deer, quail, ruffed grouse, hen pheasants, doves, Ross's and cackling geese, swans, wood duck, elder ducks, bitterns, sandhill and whooping cranes, grebes, gulls, herons, jaegers, loons, murres, petrels, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident citizen: Game, $15.25; fish, $3.25 (rod and reel). Resident citizen: Game, $1.25; fish, $1.10 (rod and reel). Issued by county and township clerks. Rod and reel license not required of persons under 18. Persons under 16 when hunting with a gun must be accompanied by adult. Owners, tenants, or their children may hunt or fish without license during open season on own or leased lands. Written permission required to hunt on land of another.

Bag limits and possession: Four squirrels and 5 rabbits a day or in possession; 2 cock pheasants a day, 4 in possession; and 4 Hungarian partridges, 15 Wilson's snipe, 4 woodcock, 4 geese including brant, 15 ducks, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, and not more than 25 coots and gallinules a day. Waterfowl, coots, and gallinules may be possessed during first 10 days of close season, but not more than 30 ducks and 8 geese, including brant, may be possessed at any one time. Woodcock and jacksnipe may be possessed only during open season.

Interstate transportation: Export prohibited of all protected game (except rabbit) taken in State; provided, a nonresident may take with him from State under his hunting license 25 game animals killed by himself. Packages containing game or fur-bearing animals or parts thereof must be marked to show contents, initial point of billing, and names and addresses of consignor and consignee.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale prohibited of all protected game (except hare or rabbit during open season).

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

[illegible] *North Dakota:* The governor, on recommendation of game and fish commissioner, may by order close or open seasons, fix bag limits, or prescribe manner in which game may be taken, but such orders may not extend the open seasons or other provisions of the Federal regulations on migratory birds.

[1] Season on migratory game birds opens at 12 o'clock noon.

[2] *Ohio:* Landowners, tenants, and employees may take hares or rabbits, when doing substantial damage to crops, trees, or shrubbery, at any time except on Sunday.

[3] Season on migratory game birds opens at 12 o'clock noon.

OKLAHOMA

Open seasons:	*Dates inclusive*
Squirrel[3]	May 15–Dec. 31.
Quail	Nov. 20–Jan. 1.[4]
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 20–Nov. 19.[5]
Dove	Sept. 1–Dec. 15.[5]
Woodcock	Nov. 15–Dec. 15.[5]
Wilson's snipe or jacksnipe	Oct. 16–Jan. 15.[5]
Rail and gallinule, other than coot	Sept. 1–Nov. 30.[5]

No open season: Deer, antelope, fox,[6] wild turkeys, prairie chickens, imported pheasants, Ross's and cackling geese, swans, wood duck, bitterns, little brown, sand-hill, and whooping cranes, grebes, gulls, herons, loons, band-tailed pigeons, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Game: Nonresident, $15. Nonresidents in States bordering on Red River may procure special license (fee, $2.50) to hunt migratory waterfowl on Red River within borders of Oklahoma. Alien, $25; resident citizen, $1.25. Fish: Nonresident, $5; nonresident tourist, 10 days, $1.25; resident (to use rod and line for game fish), $1.25. Issued by warden, deputy, or county clerk. A person may hunt without license during open season on own or leased premises actually occupied by him. Fishing license not required of any person under 16 nor of women. Application of persons under 14 for a hunting license must be approved in writing by parent or guardian. Women required to have hunting licenses. Unlawful to shoot on or across highway or railroad right of way. Unlawful to hunt on lands of another without owner's permission.

Bag limits and possession: Ten squirrels a day; 10 quail a day, 50 a season; 6 prairie chickens a day, 12 in possession; 10 ducks a day, 50 a season; 4 geese, including brant, a day, 12 a season; 20 Wilson's snipe a day, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, 25 doves, and 4 woodcocks a day. Not more than 30 ducks and 8 geese, including brant, may be possessed at any one time. Possession of game permitted during first 10 days of close season, and trophies or specimens of game lawfully taken may be possessed at any time.

Interstate transporation: Export prohibited of all protected game, but nonresident licensee may carry to his home two days' bag limit of game birds if license permit is attached.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale prohibited of all protected game.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

OREGON

Open seasons:[7,8]	*Dates inclusive*
Deer (male, with forked horns)	Sept. 20–Oct. 25.
Bear, in Jackson, Josephine, and Klamath Counties	Nov. 1–Nov. 30.
In rest of State	No close season.
Silver-gray squirrel (see exception)	Sept. 15–Oct. 20.
Exception: In Benton, Clackamas, Douglas, Lane, Linn, Marion, Multnomah, Polk, Washington, and Yamhill Counties	No close season.
Mountain or plumed, and California or valley quail, in Coos, Crook, Curry, Deschutes, Douglas, Gilliam, Jackson, Josephine, Klamath, Lake, Marion, Morrow, Sherman, Umatilla, and Yamhill Counties only	Oct. 15–Oct. 31.
Blue or sooty grouse, ruffed grouse or native pheasant (see exception)	Sept. 20–Oct. 25.
Exception: In Baker, Union, and Wallowa Counties	Aug. 20–Sept. 20.
Sage hen, in Baker and Union Counties only	Aug. 15–Aug. 25.
Hungarian partridge, in Morrow, Sherman, Umatilla, and Wallowa Counties only	Oct. 15–Oct. 31.
Chinese pheasant (see exception)	Oct. 15–Oct. 31.
Exception: In Lincoln, Tillamook, Clatsop, Wasco, Wheeler, Jefferson, Lake, Harney, and Curry Counties	No open season.
Duck, goose (except Ross's and cackling geese), brant, coot	Nov. 16–Dec. 15.[8,9]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[8,9]
Rails and gallinule, other than coot	Oct. 1–Nov. 30.[8,9]

No open season: Does and spotted fawns, moose, elk, antelope, mountain sheep, mountain goats, Franklin's grouse, fool hens, wild turkeys, introduced pheasants (except as above), bobwhite quail, sage hens (except as above), prairie chickens, doves, band-tailed pigeons, swans, Ross's and cackling geese, wood duck, auks, auklets, bitterns, little brown and sandhill cranes, fulmars, grebes, guillemots, gulls, terns, herons, jaegers, loons, murres, petrels, puffins, shearwaters, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresidents: Game, $15, angling, $3. Alien: Gun license, $25 (in addition to hunting and angling license). Resident: Game and fish, $5; game, $3; angling, $3. Hunting, $1.50, angling, $1.50, issued to residents between 14 and 18 years of age and authorizes hunting or angling in county of residence and adjoining counties. License issued by county clerks and duly appointed agents throughout the State. Guide, $3 (issued only to citizens of United States); taxidermist, $5; issued by commission. Licenses not issued to persons under 14. Owner and member of his family may hunt, trap, or fish on own premises without license during open season. Licenses, good for life, issued free of charge by State game commission to pioneers of State who arrived prior to 1870, veterans of Indian and Civil Wars, residents of State Soldiers' Home and disabled veterans of World War, resident in State more than 1 year immediately preceding application for license. Unlawful to hunt on inclosed or occupied land of another without permission of owner. Unlawful to shoot from highway or railroad rights of way, or within cemeteries or incorporated towns.

---

[4] *Oklahoma:* Quail may not be hunted except on Monday, Wednesday, and Friday of each week during open season and on Thanksgiving Day and on Christmas and New Year's Days or the preceding Saturdays if these fall on Sundays.

[5] Season on migratory game birds opens at 12 o'clock noon.

[6] Fox may be chased with hounds July 1–Feb. 29, but may not be killed, except when committing depredations.

[7] *Oregon;* Commission may open or close season on any species of game birds in any county or district for such time as it may designate and governor may suspend season on account of fire hazard in forest area.

[8] Unlawful to kill geese or other wild bird or animal at any time on islands or sand bars or within one-fourth mile of high-water line on Columbia River east of eastern entrance of Celilo Canal in Wasco County, and extending easterly along Columbia River to Oregon-Washington boundary in Umatilla County, or on islands and sand bars in Des chutes and John Day Rivers from Columbia River to point half a mile south of Oregon Trail highway bridges where the highway crosses said rivers, respectively.

[9] Season on migratory game birds opens at 12 o'clock noon.

Bag limits and possession: Two black-tailed, 1 white-tailed or 1 mule deer a season; 5 silver-gray squirrels in 7 consecutive days; 10 quail in 7 consecutive days; 4 in all of ruffed grouse, pheasants, sooty or blue grouse, and Chinese pheasants a day, 8 in 7 consecutive days, but a bag of 8 shall not include more than 1 Chinese pheasant hen; 4 Hungarian partridges a day, 8 in 7 consecutive days, 15 in all of ducks, Wilson's snipe, rails, coots, and gallinules a day, 20 in 7 consecutive days; 4 geese, including brant, a day, 28 in 7 consecutive days, but not more than 30 ducks and 8 geese, including brant, may be possessed at any one time. Migratory game birds properly tagged may be possessed during first 10 days of close season; other game, when properly tagged, during close season.

Interstate transportation: Export of all protected game prohibited, except when tagged with metal seal and accompanied by permit from State warden showing kind of game and names and addresses of consignor and consignee.

Game taken outside of State and legally exported may be imported and possessed as authorized by permit and tag (fee, 5 cents) obtained from State game warden, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Sale: Sale of all protected game prohibited. Commission may make regulations permitting sale of game except migratory birds.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

PENNSYLVANIA

Open seasons:[10]	*Dates inclusive*
Deer (male, with 2 or more points to 1 antler), bull elk (with 4 or more points to 1 antler)	Dec. 1–Dec. 15.[11]
Bear (over 1 year old)	Nov. 10–Dec. 15.[11]
Raccoon (see exception)	Oct. 15–Dec. 15.
Exception: In Adams, Bedford, Berks, Bucks, Carbon, Chester, Cumberland, Dauphin, Delaware, Fayette, Franklin, Fulton, Greene, Lancaster, Lebanon, Lehigh, Montgomery, Philadelphia, Washington, and York Counties	Nov. 1–Jan. 1.
Hare, rabbit, black, gray, and fox squirrel, male pheasant	Nov. 1–Nov. 30.
Red or pine squirrel	Nov. 1–Aug. 15.
Wild turkey, quail	Nov. 1–Nov. 15.
Ruffed grouse (12 days)	Nov. 2–4; 9–11; 19–21; 26–28.
Blackbird	Oct. 15–Nov. 30.
Woodcock	Oct. 15–Nov. 14.[12]
Duck, goose (except Ross's and cackling geese), brant, coot	Oct. 1–Oct. 31.[12]
Wilson's snipe or jacksnipe, gallinule	Oct. 1–Nov. 30.[12]
Rails, other than coot and gallinule	Sept. 1–Nov. 30.[12]

No open season: Cow elk and calves having less than 4 points to one antler; does, fawns, bear cubs under 1 year of age; Hungarian partridges; pheasant hens, doves, swans, Ross's and cackling geese, wood duck, eider ducks, reedbirds, auks, bitterns, little brown and sand-hill cranes, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shear-waters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: *Game:* Nonresident and alien (reciprocal), minimum, $15. Issued by county treasurer or department of revenue. Resident, $2. Licenses not issued to minors under 14, and minors between 14 and 16 must furnish written consent of parent or guardian. Licensee required to wear tag displayed on middle of back.

Resident citizen and members of family or employees residing upon and cultivating land in State as either owner or lessee may hunt during open season on such land and with consent of owner, on adjoining land without a license. Taxidermist license, fee $25.

Licensed hunters, within 30 days after expiration of license, must report amount of game killed.

Aliens not permitted to hunt or be possessed of dogs or firearms.

Fishing: Nonresident pays same fee charged nonresident by State where applicant resides, but not less than $2.50 (10 cents extra to county treasurer); issued by county treasurer or department of revenue.

Resident, $1.50 (10 cents extra to county treasurer); issued by county treasurer or department of revenue. License not required of minors under 16. Landowners and members of family who reside upon their own farms or other lands throughout the entire year may angle in waters on or adjacent thereto during open season without license.

Bag limits and possession: One deer a day or season (6 to hunting party); 1 elk a day or season (individual or party); 1 bear a day or season (4 to hunting party); 3 raccoons a day, 10 a season; 3 hares a day, 15 a season; 5 rabbits a day, 30 a season; 6 squirrels (black, gray, fox) a day, 20 a season; 8 quail a day, 25 a season; 2 pheasant a day, 6 a season; 1 wilk turkey a day or season; 2 ruffed grouse a day, 12 a season; 4 woodcock a day, 20 a season; 20 jacksnipe a day; 15 ducks a day, 60 a season, 30 in possession; 4 geese a day, including brant, 30 a season, 8 in possession; 15 rails, 15 gallinules, 25 coot a day. Possession of migratory game birds permitted during season and first 10 days of close season; other game first 30 days of close season.

Interstate transportation: Export of all protected game taken in State prohibited; provided, a nonresident licensee may take out with him on same conveyance two day's limit of game except elk. Small game must be accompanied by owner and if concealed must be tagged to show name and address of owner, county where killed, and number of each species in package. Large game may be shipped by express when plainly marked to show name and address of owner and county in which killed. Specimens and trophies of game legally taken may be shipped by parcel post or otherwise to a licensed taxidermist for mounting, if marked to show contents, but no such shipments may be made to points outside the State without a permit. Skins of bears or raccoons may be shipped out of State by parcel post or otherwise if package is marked to show contents.

Game taken outside of State and legally exported may be possessed at any time, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Sale: Sale prohibited of wild deer and rabbits taken in the State, and of all other game wherever taken. Trophies of game not killed in State and skins of bears and raccoons wherever taken may be purchased or sold at any time.

Miscellaneous: Automatic gun prohibited.

Federal regulations do not permit the use of more than 10 live-goose decoys at any one stand or blind in the hunting of wild geese.

RHODE ISLAND

Open seasons:	*Dates inclusive*
Gray squirrel, hare, rabbit[13]	Nov. 1–Dec. 31.
Quail or bobwhite, ruffed grouse or partridge, cock pheasant (see exceptions)	Nov. 1–Dec. 31.
Exceptions: Cock pheasants in town of New Shoreham (4 days only), Oct. 21, Nov. 4 and 18, and Dec. 2, and in town of Jamestown (2 days only), Nov. 2 and 9.	

---

[10] *Pennsylvania:* Seasons may be extended, closed, or shortened and bag limits reduced by commission.

[11] In killing deer, elk, or bears, only one all-lead, lead-alloy, soft-nosed, or expanding bullet may be used at each discharge. The use of steel-jacketed bullets is prohibited. Bow and arrow may be used.

[12] Season on migratory game birds opens at 12 o'clock noon.

See footnote 13 on p. 36, col. 1.

Open seasons—Continued.	*Dates inclusive*
Duck, goose (except Ross's goose, cackling goose, and snow geese), brant, coot	Nov. 1–Nov. 30.[14]
Wilson's snipe	Oct. 1–Nov. 30.[14]
Woodcock	Nov. 1–Nov. 19.[14]
Rail and gallinule, other than coot	Sept. 1–Nov. 30.[14]

No open season: Deer,[13] doves, Hungarian partridges, hen pheasants, Ross's and cackling geese, snow geese, swans, wood duck, eider ducks, auks, bitterns, little brown and sand-hill cranes, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game, $10.25; fish, $2.50.[15] Alien: Game, $15.25; fish, $2.50, alien resident for 1 year; $5, alien, not resident for 1 year. Resident: Game, $2.25; fish, $1.25. Issued by city and town clerks. Fishing license not required of women, nor of males under 18. License not required of resident or his immediate family to hunt on own or leased agricultural lands on which actually domiciled; nonresident owning real estate valued at not less than $500, and nonresident member or guest of club incorporated for hunting or fishing purposes prior to January 1, 1909, which owns real estate assessed for taxation at value of not less than $1,000, may procure license at a fee of $2.25; licenses not issued to minors under 15. Consent of owner required for hunting upland game birds on land of another from December 14 to October 15.

Bag limits and possession: Two ruffed grouse or partridges, 3 cock pheasants (except 2 a day in towns of New Shoreham and Jamestown); 6 quail, 15 ducks, 4 geese, including brant, 4 woodcock, 15 Wilson's snipe, 15 coots, 15 rails, 25 in all of rails and gallinules a day, but not more than 15 of any one species of gallinules, and not more than 15 game birds of all kinds, of which not more than 8 may be wild geese, including brant, in possession at one time. Possession of waterfowl, coots, and gallinules permitted during first 10 days of close season.

Interstate transportation: Export of all game prohibited; provided, a nonresident licensee may take out under his license 10 wild fowl (8 geese, including brant) or birds in one calendar year if carried open to view.

Game taken outside of State and legally exported may be imported and possessed as authorized by permit from commissioners of birds, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Sale: Sale of all game birds prohibited.

Miscellaneous: Unlawful to import live game birds or animals except under permit.

Federal regulations do not permit the use of more than 10 live goose decoys in the hunting of wild geese.

SOUTH CAROLINA

Open seasons:[16] [17]	*Dates inclusive*
Deer (male)[16] (see exceptions)	Aug. 15–Jan. 1.
Exceptions: In Greenville, Pickens, and Oconee Counties (1 day only)	Jan. 1, 1932.
In Chester, Lexington, Richland, and Saluda Counties	No open season.
Bear	No close season.
Raccoon, opossum, fox, rabbit,[18] squirrel[18] (see exceptions)	Sept. 1–Mar. 1.
Exceptions: Raccoon, opossum, in Hampton County	Nov. 1–Feb. 1.
Fox, in Hampton County	Nov. 26–Mar. 1.
Rabbit, in Abbeville, Laurens, and McCormick Counties	Nov. 26–Mar. 1.
Fox squirrel, in Oconee County (1 day only)	Jan. 1, 1932.
Squirrel, in Cherokee County	Nov. 26–Feb. 1.
Squirrel, in York County	Nov. 1–Mar. 1
Wild turkey, partridge (quail) (see exceptions)	Nov. 26–Mar. 1.
Exceptions: Turkey, in Cherokee County	Nov. 26–Feb. 1.
Turkey, in Greenville County (1 day only)	Jan. 1, 1932.
Partridge, in Cherokee, Chester, Fairfield, Greenville, Lancaster, Pickens, and York Counties	Nov. 26–Feb. 1.
Partridge, in Edgefield, Newberry, and Saluda Counties	Nov. 26–Feb. 15.
Partridge, in Spartanburg County (also 1 day, Nov. 26)	Dec. 20–Jan. 31.
Blackbird	Nov. 26–Mar. 1.
Doves	Sept. 1–Sept. 30.[19] Nov. 20–Jan. 31.[19]
Woodcock	Dec. 1–Dec. 31.[19]
Duck, goose (except Ross's, cackling, and snow geese), brant, and coot	Nov. 16–Dec. 15.[19]
Wilson's snipe or jacksnipe	Nov. 1–Jan. 15.[19]
Rails and gallinules (other than coot)	Sept. 1–Nov. 30.[19]

No open season: Does, ruffed grouse (pheasants), Ross's and cackling geese, snow geese, swans, wood duck, reedbirds, auks, bitterns, little brown, sand-hill, and whooping cranes, gannets, grebes, gulls, herons, jaegers, loons, murres, petrels, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game, $15.25; fish, $10.25. Issued by county game warden. Resident: Game, State, $3.10; county of residence, $1.10. Issued by county game warden and his agents.

No license required of resident owners, tenants, their children, or, under written permission, their employees, to hunt during open season on own lands. Confederate veteran wearing his cross of honor may hunt and fish in any county of State without license.

Consent of owner or manager required to hunt on land of another.

Hunting clubs and game preserves must register with chief game warden of State, file list of members including names and addresses, and during March of each year report number and kind of game killed by members during season.

Bag limits and possession: Five deer, 20 wild turkeys a season; 15 squirrels, 15 quail (partridges), 2 turkeys, 25 doves, 15 ducks, 4 geese, including brant, 4 woodcock, 20 Wilson's snipe, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day. Not more than 30 ducks and 8 geese, including brant, may be possessed at any one time. Possession of migratory birds permitted during first 10 days of close season.

---

[13] *Rhode Island:* Deer injuring crops may be killed at any time by owner or occupant of premises under written permit from secretary of state after investigation by commissioners of birds. Any person killing or wounding a deer must report within 24 hours to commissioners of birds. Rabbits destroying crops or trees may be killed by landowner or employee at any time.

[14] Season on migratory game birds opens at 12 o'clock noon.

[15] Fee required of nonresident angler equal to that required of nonresident in his State of residence.

[16] *South Carolina:* Chief game warden of State may close seasons for periods not exceeding 10 days at one time on any waters or swamps of State when necessary to protect deer or other game on account of floods or other abnormal conditions; and on recommendation of any county legislative delegation may shorten season on any kind of game.

[17] Season opens on Thanksgiving Day except as otherwise indicated.

[18] Between Sept. 1 and Thanksgiving Day rabbits may be hunted without firearms, and squirrels may be hunted without dogs, except in Abbeville, Laurens, and McCormick Counties; rabbits may only be hunted with firearms, with consent of landowner, from Nov. 26 to Mar. 1, and squirrels may only be hunted without dogs in Oconee County from Sept. 1 to Nov. 26, and in York County from Nov. 1 to Nov. 26.

[19] Season on migratory game birds opens at 12 o'clock noon.

Interstate transportation: Export of all resident nonmigratory game taken in State prohibited, except that a landowner or licensee may export under shipping tag from chief game warden of State one day's bag limit of resident nonmigratory game a week, if not for sale. Unlawful for any transportation company to receive for shipment out of the State any deer or other resident nonmigratory game unless duly tagged. Under Federal regulations not more than two days' limit of migratory birds may be taken or shipped out of the State in any one calendar week. All packages containing migratory birds must be marked to show actual contents and names and addresses of consignor and consignee. No game may be removed from the State for sale.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale prohibited of deer, quail (partridges), doves, wild turkeys, reedbirds, and all other migratory birds.

Miscellaneous: Game may not be kept in cold-storage or refrigerating plant except in private dwelling.

Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

SOUTH DAKOTA

Open seasons:	*Dates inclusive*
Deer (male with 2 or more points to 1 antler), in Meade, Lawrence, Pennington, Custer, and Fall River Counties only	Nov. 1–Nov. 20.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 1–Oct. 31.[20]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[20]
Rail and gallinule, other than coot	Sept. 16–Nov. 30.[20]

No open season: Deer, except as above, elk, antelope, mountain sheep, quail, Hungarian partridges, doves, partridges or ruffed grouse, prairie chickens or pinnated grouse, white-breasted or sharp-tailed grouse, sage grouse, introduced pheasants,[21] upland plover, woodcock, Ross's and cackling geese, swans, wood duck, eider ducks, bitterns, little brown, sand-hill, and whooping cranes, grebes, gulls, heron, loons, shearwaters, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident or alien: Big game, $25; small game, $25; fish, $3. Issued by game warden or county treasurer. Resident: Big game, $5; small game, $1; fish, $1. Issued by county treasurer, game and fish commission, and deputies; special license, small game, $3 (hunting; also authorizes shipment of 50 birds in the State as specified in license); issued by game and fish commission. Fishing license not required of resident women, or of resident males under 18. Hunting and fishing license not issued to persons under 15 unless applied for by parent or guardian. Hunting game birds during open season on own land permitted without license. Unlawful to hunt on land of another without permission of owner or lessee. Taxidermist, $2.

Bag limits and possession: One deer a year; 15 ducks, Wilson's snipe, coots, gallinules, sora, and other rails in the aggregate of all kinds a day, 30 in all in possession; 4 geese and brant combined, a day, 8 combined in possession at any one time. Possession permitted during open season and 5 days thereafter.

Interstate transportation: Export of all protected game prohibited, provided, a nonresident may, under permit of the game and fish commission, export 1 deer lawfully killed, and not more than 5 upland nonmigratory birds under each of 5 of the coupons, and not more than 5 migratory game birds under each of 5 of the coupons attached to his nonresident license; but not more than 8 geese, including brant, may be exported by one person in any one calendar week, and if exported by common carrier or as personal baggage tags attached to hunting license must be affixed to each shipment.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of all protected game prohibited; provided skins, heads, and antlers of deer lawfully killed may be sold.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

TENNESSEE

Open seasons:	*Dates inclusive*
Deer (male, with horns having 2 or more spikes each)	Dec. 1–Dec. [illegible].
Squirrel (see exceptions)	June 1–Dec. 31.
Exceptions: In Johnson County	July 1–Dec. 1.
In Trousdale County	No close season.
Rabbit, quail (partridge), wild turkey, (see exceptions)	Nov. 25–Jan. 31.
Exceptions: Rabbit, in Sullivan County	Nov. 15–Jan. 1.
Rabbit, in Houston, Dickson, and Trousdale Counties	No close season.
Quail, in Johnson County	Nov. 1–Jan. 1.
Quail, in Sullivan County	Nov. 15–Jan. 1.
Pheasant (see exception)	No open season.
Exception: In Johnson County	Nov. 1–Jan. 1.
Doves	Sept. 1–Dec. 15.[22]
Duck, goose (except Ross's goose and cackling goose), brant, coot	Nov. 16–Dec. 15[22]
Wilson's snipe or jacksnipe	Nov. 1–Jan. 15.[22]
Rail, other than coot and gallinule	Sept. 1–Nov. 30.[22]
Gallinule	Nov. 1–Nov. 30.[22]

No open season: Does and fawns; grouse, ring-necked and Mongolian pheasants, woodcock, Ross's goose, cackling goose, swans, wood duck, bitterns, sand-hill and whooping cranes, grebes, gulls, herons, loons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident. Game, $15 (may hunt on own land without license); fish, $2.50. Resident, State, $2 (resident must hold State license to hunt on Reelfoot Lake); county, $1 (county licensee may obtain State license for $1). Issued by county clerks. Licensee required to wear license tag displayed in center of back of outer garment.

Owners and tenants may hunt without license on land on which they reside. Unlawful to hunt on tillable or inclosed lands of another without permission.

Reelfoot Lake.—Guide or pusher, $1 (issued to residents only).

Bag limits and possession: Two deer, 3 wild turkeys a season; 10 squirrels, 15 quail, 15 other game birds a day, but not more than 4 geese, including brant, 15 ducks, 15 of any one species of rails (other than sora) and gallinules a day. Not more than 30 ducks and 8 geese, including brant, may be possessed at any one time.

Reelfoot Lake.—Fifteen ducks, 4 geese, including brant, 20 Wilson's snipe, 20 in all of rails, coots, and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules, but not more than 20 in all of game birds a day.

Interstate transportation: Export of all protected game prohibited; provided, nonresident licensee may take out of State, if carried openly, game birds legally killed by him (except that 25 birds only may be exported from Reelfoot Lake), but not more than 30 ducks, 8 geese, 16 brant, 40 Wilson's snipe, 50 coots, 50 sora, 50 in all of rails and gallinules, but not more than 30 of any one species of rails (other than sora) and gallinules, and 50 doves may be exported by one person in any one calendar week.

---

[20] *South Dakota:* Season on migratory game birds opens at 12 o'clock noon.

[21] Chinese ringneck or English pheasants, partridges or ruffed grouse, prairie chickens or pinnated grouse, white-breasted or sharp-tailed grouse, and sage grouse may be taken and shipped under regulations of game and fish commission, Pierre.

[22] Season on migratory game birds opens at 12 o'clock noon.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of all protected game (except rabbits) killed in State prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

TEXAS

Open seasons:	*Dates inclusive*
Deer (male, with pronged horn) [23] (see exceptions), bear	Nov. 16–Dec. 31.
Exceptions: Black-tailed deer (male, with pronged horn), west of Pecos River	Nov. 16–Nov. 30.
Deer, in Bastrop, Callahan, Eastland, Harrison, Hemphill, Hutchinson, Palo Pinto, Parker, Roberts, San Saba, and Stephens Counties (1934)	No open season.
Squirrel (see exceptions)	May 1–July 31. Oct. 1–Jan. 31.
Exceptions: In Angelina, Chambers, Hardin, Jasper, Jefferson, Liberty Nacogdoches, Newton, Orange, Polk, Sabine, San Augustine, Shelby, Trinity, and Tyler Counties	Nov. 1–Jan. 31.
In Morris and Smith Counties	May 1–July 31. Nov. 1–Jan. 31.
In Panola County	July 1–July 31. Nov. 1–Dec. 31.
In Wood County	Oct. 1–Jan. 15.
In Parker and Young Counties	No open season.
In Bandera, Bastrop, Bell, Blanco, Bosque, Brown, Burnet, Caldwell, Callahan, Comal, Comanche, Concho, Cooke, Coryell, De Witt, Dimmit, Eastland, Edwards, Erath, Fayette, Gillespie, Goliad, Gonzales, Guadalupe, Hamilton, Hays, Hill, Hood, Irion, Jackson, Karnes, Kendall, Kerr, Kimble, Lampasas, Lavaca, Llano, Mason, McCulloch, Medina, Menard, Mills, Montague, Real, San Saba, Schleicher, Stephens, Sterling, Tarrant, Throckmorton, Tom Green, Travis, Uvalde, Victoria, Washington, Wharton, Williamson, Wilson, Wise, and Zavalla Counties	No close season.
Quail or partridge, chachalaca or Mexican pheasant (see exceptions)	Dec. 1–Jan. 16.
Exceptions: Quail, in Wood County	Sept. 1–Oct. 31.
Quail, in Falls and Johnson Counties	Dec. 1–Dec. 31.
Quail, in Atascosa, Howard, Stephens, and Wharton Counties	No open season.
Open season—Continued.	*Dates inclusive*
Prairie chicken or pinnated grouse (see exception)	Sept. 1–Sept. 4.
Exception: In Collingsworth and Wheeler Counties	No open season.
Wild-turkey gobblers (see exceptions)	Nov. 16–Dec. 31.
Exceptions: In Angelina, Bastrop, Brazos, Burleson, Cherokee, Grimes, Harris, Houston, Jasper, Lee, Leon, Madison, Montgomery, Nacogdoches, Newton, Polk, Robertson, Sabine, San Augustine, San Jacinto, Trinity, Tyler, Walker, and Washington Counties	Mar. 1–Apr. 30.
In Callahan, Eastland, Harrison, Palo Pinto, Panola, San Saba, Shackelford, and Stephens Counties	No open season.
Mourning dove, in north zone (except in Howard County, no open season)	Sept.1–Oct.31.[24,26]
In south zone	Oct.1–Nov.30.[24,26]
White-winged dove, in north zone	Aug. 8–Oct. 31.[25]
In south zone	Aug. 20–Oct. 31.[25]
Duck, goose (except Ross's goose and cackling goose) brant, coot	Nov. 16–Dec. 15.[26]
Wilson's snipe or jacksnipe, in north zone	Oct.16–Jan.15.[24,26]
In south zone	Nov.1–Jan.15.[24,26]
Rail, other than coot and gallinule	Sept. 1–Oct. 31.[26]
Gallinule, in north zone	Oct.16-Nov.30.[24,26]
In south zone	Nov. 1-Nov.30.[24,26]

No open season: Does, fawns, spike bucks, antelope, mountain sheep, turkey hens, robins, pheasants (except chachalacas), reedbirds, (rice birds), woodcock, Ross's and cackling geese, swans, wood duck, bitterns, little brown, sand-hill, and whooping cranes, gannets, grebes, gulls, herons, jaegers, loons, petrels, band-tailed pigeons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident or alien: Game, $25; fish, $5, nonresident, 5-day license, $1.10. Resident citizen: Game, $2; not required in county of residence; fish (artificial lure), $1.10; issued by commission, deputies, and county clerks. Boat (carrying hunters), $2; club or shooting preserve, $5. Issued by commission. Manager of club or shooting preserve must keep record, require guests to register number of game killed, and make complete report to commission by Feb. 10 of each year. Hunting license not required of persons under 17. License does not entitle holder to hunt on inclosed and posted lands of another without consent of owner or agent.

---

[23] *Texas* Unlawful to kill deer having less than 8-point antlers in Frio, La Salle, Live Oak, and McMullen Counties.

[24] North and south zones divided by line running approximately from Rio Grande River east through Del Rio, thence following center of main track of Southern Pacific Railroad through Spofford, Uvalde, and Hondo to San Antonio; thence following International & Great Northern Railroad to Austin; thence along Houston & Texas Central Railroad through Elgin, Giddings, and Brenham to Brazos River; thence with center of Brazos River to Beaumont branch of Santa Fe Railway; thence following Gulf, Colorado & Santa Fe Railroad through Navasota, Montgomery, and Conroe to Cleveland; thence along Houston, East & West Texas Railroad to point where it strikes Louisiana line. For detailed boundary line see Service and Regulatory Announcements—B. S. No. 76, obtainable from Department of Agriculture, Washington, D. C., or State game law to be had from game, fish, and oyster commission, Austin, Tex.

[25] For white-winged doves the north and south zones are divided by the Texas-Mexican Railway from Laredo to Corpus Christi.

[26] Season on migratory game birds opens at 12 o'clock noon. Waterfowl may not be hunted or killed after 12 o'clock noon in Harrison and Marion Counties.

Bag limits and possession: Two deer (west of Pecos River, 1 blacktail), 1 bear, 3 turkey gobblers a season; 10 squirrels a day; 12 in all of quail and chachalacas a day, 36 in 7 days, 36 of each in possession; in Wood County, 8 a day, 24 in 7 days; 10 prairie chickens a day or season; 15 doves and white wings a day, 45 in 7 days or in possession, in Wood County, 10 a day, 40 in 7 days; 25 in all of ducks, rails, coots, gallinules, a day, but not more than 15 of any one species of rails (other than sora) and gallinules a day, 50 in all in 7 days, 4 geese and brant combined a day, 12 in 7 days; 15 ducks, 20 jacksnipe a day, but not more than 30 ducks and 8 geese, including brant, may be possessed at any one time. Possession of all game permitted during open season and 10 days thereafter.

Interstate transportation: Export prohibited of all game, except that nonresident licensee may ship game lawfully possessed to his home for own use under affidavit (fee, 25 cents), that it was lawfully killed and will not be bartered or sold; provided that not more than two days' limit of migratory birds may be exported in any one calendar week. Game may be shipped to taxidermist for mounting under affidavit that shipper killed the specimen and that it is not being preserved for sale.

Game taken outside the State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale prohibited of all protected game.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

UTAH

Open seasons:[27]	*Dates inclusive*
Deer (buck, with horns not less than 5 inches long)[28]	Oct. 20–Oct. 30.
Bear, rabbit, hare	No close season.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 1–Oct. 31.[29]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[29]

No open season: Does, fawns, elk,[30] antelope, mountain sheep, mountain goats, quail, any species of grouse or sage hens, Hungarian partridges, mourning doves,[31] Ross's and cackling geese, swans, wood duck, rail, gallinules, bitterns, sand-hill cranes grebes, gulls, herons, loons, band-tailed pigeons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident citizen: Small game and fish, $10; deer and bear, $15; fish, $3. Resident citizen (male): Game and fish, 12 to 16 years, $1; 16 and over, $3; game, $2; fish, $2; females, 16 and over, game and fish, $1. Alien: Fish, $7.50. Guide, $5 (resident only). Aliens prohibited from hunting in State or owning firearms. Resident citizens, males under 12, and females under 16, not required to obtain licenses to fish. Issued by State fish and game commissioner or deputy, county clerk, or deputy or authorized agent.

Bag limits and possession: One buck a season; 25 ducks, geese, brant, Wilson's snipe, coots, and gallinules a day, but not more than 15 ducks, 4 geese including brant; 15 Wilson's snipe or more than 15 of any one species of gallinules a day. Not more than 25 game birds in all may be taken in one day; 50 in all of game birds in possession at any one time, but not more than 30 ducks and 8 geese, including brant, may be possessed at any one time.

Interstate transportation: Export of all game prohibited, except under permit and regulations of commissioner.

Game taken outside of State and legally exported may be possessed at any time, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season. Persons possessing game during close season in State must show lawful taking.

Sale: Sale of all game prohibited; except that rabbits, bears, and hides of deer legally killed may be sold.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

VERMONT

Open seasons:	*Dates inclusive*
Deer (with horns not less than 3 inches long)[32] (see exception)	Nov. 21–Nov. 30.
Exception: In Franklin County	**No open season.**
Hare, rabbit	Oct. 1–Feb. 29.
Gray squirrel, woodcock, ruffed grouse	Oct. 1–Oct. 31.
Quail	Sept. 15–Nov. 30.
Duck (see exception), goose (except Ross's goose and cackling goose), brant, coot	Oct. 1–Oct. 31.[33]
Exception: Ducks on waters or shores of Joes Pond in towns of Danville, Cabot, and Walden, Stone Pond or Shadow Lake in town of Glover, Caspian Lake in town of Greensboro, and Groton or Lunds Pond in town of Groton (1937).	
English or Wilson's snipe (jacksnipe), gallinule	Oct. 1–Nov. 30.[33]

No open season: Elk, moose, caribou (1942); does, fawns, doves, rail; pheasants, European partridges (1933); Ross's and cackling geese, swans, wood duck, auks, bitterns, sand-hill and whooping cranes, grebes, gulls, herons, jaegers, loons, murres, petrels, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game and fish, $10.50; fish, $3.15, but residents of States or countries charging larger nonresident angling license fee must pay fee charged nonresidents in own State or country. Resident: Game and fish, $1.50; game, $1; fish, $1. Issued by town clerks. Citizen of United States who owns $1,000 taxable property in Vermont pays same fees as resident. Alien resident who has not declared his intention pays same fees as nonresident; declarant resident for six months in State pays same fees as resident.

Hunting licenses not issued to persons under 16 without written consent of parent or guardian. Owners of farm lands and their resident minor children or tenants may hunt and fish without a license on own lands during open season. Fishing license not required of persons under 15.

---

[27] *Utah:* Commissioner may shorten or close open season and reduce bag limit on any species of game birds or animals needing additional protection.

[28] Person under 16 may not hunt deer.

[29] Season on migratory game birds opens at 12 o'clock noon.

[30] Elk doing damage may be killed under authority of commissioner.

[31] Commissioner, upon determining that quail, any species of grouse or sage hens, Hungarian partridges, pheasants, or mourning doves have increased sufficiently, may prescribe an open season and fix bag limits on any such birds.

[32] *Vermont.* Landowner, member of his family, or authorized employee may kill deer doing damage to his fruit trees or crops, but person under whose direction a deer is so killed must, within 12 hours, report the matter in a signed statement to nearest fish and game warden. Deer may also be killed at any time in orchard zones established by commissioner, but such killing must forthwith be reported to owner of orchard and county warden.

[33] Season on migratory game birds opens at 12 o'clock noon.

Bag limits and possession: One deer a season; 4 ruffed grouse a day, 25 a season; 4 woodcock a day, 25 a season; 5 hares or rabbits a day or in possession; 4 gray squirrels a day or in possession; 4 quails a day, 10 ducks a day, 40 a season; 5 geese a season but not more than 4 a day, including brant; 10 Wilson's snipe a day; 25 coots; 25 gallinules but not more than 15 gallinules of any one species a day.

Possession of waterfowl, coots, and gallinules permitted during first 10 days of close season, but not more than 30 ducks and 5 geese, including brant, may be possessed at any one time.

Interstate transportation: Export prohibited of all protected game, except hares and rabbits; provided, a nonresident licensee may export one deer under license coupon and one day's bag limit of game birds under permit, but must accompany shipment; resident may export (if not for sale) one day's bag limit of game birds under special permit from commissioner and one deer a season for sale, if it is tagged and license is presented to carrier for cancellation, but laws of State to which deer is shipped must be complied with. Packages containing game delivered to a common carrier for transportation must be tagged to show number and kind of such game therein, names of consignor and consignee, station from which shipped, destination, and number of license. License of shipper must be presented to agent of transportation company for indorsement thereon of quantity of game offered for transportation. Head, hides, feet, and fur of quadrupeds and plumage and skins of game birds legally killed and possessed may be transported without tags if accompanied by owner.

Game taken outside of State and legally exported may be possessed as authorized by permit obtained from fish and game commissioner, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Sale: Sale of squirrels and all protected game birds prohibited; deer may be sold during open season and for a "reasonable time thereafter," and hares and rabbits during open season. Head and hide of deer legally taken may be sold.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

VIRGINIA

Open seasons:[34]	*Dates inclusive*
Deer (male, with horns visible above hair):	
East of Blue Ridge Mountains (see exception)	Nov. 15–Dec. 31.
Exception: In Gloucester, King George, Lancaster, Northumberland, Richmond, Stafford, and Westmoreland Counties	No open season.
West of Blue Ridge Mountains (see exceptions)	Nov. 15–Nov. 30.
Exceptions: In Alleghany, Bath, and Highland Counties	Nov. 15–Nov. 20.
In Augusta, Bland, Frederick, Grayson, Montgomery, Roanoke, Rockingham, Russell, Shenandoah, Smyth, Tazewell, Washington, and Wythe Counties	No open season.
Elk[35] (with horns visible above hair) (see exception)	Dec. 15–Dec. 31.
Exception: Bull elk, in Bland, Craig, Giles, Montgomery, and Pulaski Counties (3 days)	Dec. 1, 2, 3.
Black bear (adult)	Nov. 15–Jan. 31.
Rabbit[36] (see exceptions)	Nov. 15–Jan. 31.
Exceptions: In Culpeper, Fairfax, Fauquier, Greene, Loudoun, Orange, Prince William, Rappahannock, and Stafford Counties	Nov. 15–Dec. 31.
West of Blue Ridge Mountains (except in Alleghany, Bath, and Highland Counties)	Nov. 15–Dec 31
In Alleghany, Bath, and Highland Counties	Nov 15–Nov. 30.
Squirrel:[36]	
East of Blue Ridge Mountains (see exceptions)	Sept. 1–Sept. 30. Nov. 15–Jan. 31.
Exceptions: In Accomac and Northampton Counties	Dec. 1–Dec. 31.
In Appomattox, Buckingham, Chesterfield, Culpeper, Gloucester, Louisa, and Prince Edward Counties	Nov. 15–Jan. 31.
In Fairfax, Fauquier, Greene, Loudoun, Orange, Prince William, and Rappahannock Counties	Sept. 1–Sept. 30. Nov. 15–Dec. 31.
West of Blue Ridge Mountains (see exceptions)	Sept. 1–Dec. 31.
Exceptions: In Alleghany County	Sept. 1–Sept. 10. Nov. 15–Dec. 15.
In Frederick County	Sept. 1–Oct. 15. Nov. 15–Dec. 31.
In Bath and Highland Counties	Sept. 1–Sept. 10. Nov. 15–Nov. 30.
Wild turkey, ruffed grouse, bobwhite quail (see exceptions)	Nov. 15–Jan. 31.
Exceptions: In Culpeper, Fairfax, Fauquier, Greene, Loudoun, Orange, Prince William, Rappahannock, and Stafford Counties	Nov. 15–Dec. 31.
Turkey, in Albemarle, Franklin, Henry, Lancaster, Northumberland, Richmond, and Westmoreland Counties	No open season.
West of the Blue Ridge Mountains (see exceptions)	Nov. 15–Dec. 31.
Exceptions: Turkey, in Giles, Lee, Pulaski, Roanoke, Russell, Scott, Smyth, Tazewell, Washington, and Wise Counties	No open season.
Turkey, ruffed grouse, in Alleghany County	Nov. 15–Dec. 15.
In Bath and Highland Counties	Nov. 15–Nov. 30.
Woodcock	Nov. 15–Dec. 15.[37]
Mourning dove	Sept. 1–Dec. 15.[37]
Duck, goose (except Ross's goose, snow geese, and cackling goose), brant, coot	Nov. 16–Dec. 15.[37]
Wilson's snipe or jacksnipe	Nov. 1–Jan. 15.[37]
Rail and gallinule (other than coot)	Sept. 1–Nov. 30.[37]

No open season: Does, fawns, Hungarian partridges, ringneck, golden, and silver pheasants, Ross's and cackling geese, snow geese, swans; wood duck, eider ducks, reedbirds, auks, bitterns, sand-hill cranes, fulmars, gannets, grebes, gulls, herons, loons, murres, petrels, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

---

[34] *Virginia:* Commission of game and inland fisheries may by regulation further restrict the time, manner, and means by which game may be taken.

[35] Elk doing damage to crops or fruit trees may be killed at any time while actually on premises, but killing must be reported to game warden.

[36] Residents of State may kill rabbits or hares and squirrels on their own lands at any time.

[37] Season on migratory game birds opens at 12 o'clock noon. Wild fowl may not be hunted on Wednesdays, Saturdays, or Sundays, on Back Bay Princess Anne County, nor on Wednesdays, Thursdays, or Sundays elsewhere east of Blue Ridge Mountains except in Accomac and Northampton Counties.

Hunting, trapping, and fishing licenses (combined): Nonresident: $15.50 (additional county certificates, fee $2.50 for nonresidents, 50 cents for residents, required for bull elk in Bland, Craig, Giles, Montgomery, and Pulaski Counties); angling $5.[38] Commissioned or enlisted members of Army, Navy, or Marines stationed or located in Virginia pay same fees as residents for hunting licenses. Alien: Game, $15.50, angling, $5 (alien owner of real estate resident for five years, same as resident). Resident: State, $3; county, $1; (county license or nonresident angling license may be exchanged by holder for State license or nonresident hunting, trapping, and fishing license, respectively, on payment of difference in cost plus a fee of 25 cents to issuing officer). Issued by clerks of circuit and corporation courts and designated agents. Licensee required to wear license button. Certificate in lieu of lost or destroyed license issued under affidavit and on payment of clerk fee of 25 cents.

Residents, nonresidents, and aliens and their husbands, wives, or children may hunt, trap, or fish on own premises and fish in waters bounding or adjoining own premises during open season without license; tenant, renter, or lessee, under written consent of owner or landlord, may hunt, trap, or fish during open season without license on premises on which he resides.

Fishing license required in all inland waters, including brackish and fresh-water streams, creeks, bays (including Back Bay), inlets, and ponds in the tidewater counties, but not required of any person under 16.

Written consent required to hunt or trap on lands of another. Does not apply to persons hunting foxes or deer with hounds or dogs, where the chase begins on other lands, nor on uninclosed mountain lands west of the Blue Ridge not used for cultivation, except in Alleghany, Bath, Bland, Craig, Giles, and Highland Counties, and mountains in western Rockingham County.

Special licenses, Back Bay, Princess Anne County: Battery, sinkbox, mat blind,[39] fee $100 (limited to not more than 50 batteries and sinkboxes and 27 mat blinds actually used in 1927-28; any license not renewed each year may not be reissued until number of batteries and sinkboxes is less than 25 and that of mat blinds less than 11). Shore blind, $50. Issued by clerk, circuit court, Princess Anne County.

Bag limits and possession: One elk a season; 1 deer a day, 2 a season; 10 each of squirrels and hares (rabbits) a day, 150 of each a season; 2 turkeys a day, 4 a season (2 a season in Rockbridge County); 4 grouse a day, 20 a season; 15 quail a day, 150 a season; 25 doves a day, 250 a season; 4 woodcock a day, 25 a season; 15 ducks a day, 350 a season; 4 geese and brant combined a day, 50 geese, but not more than 30 brant, a season; 20 Wilson's snipe a day, 250 a season; 25 sora a day, 500 a season; 25 coots a day, 250 a season; 25 in all of rails (other than sora) and gallinules but not more than 15 of any one species a day, 250 a season. Possession permitted during open season and 10 days thereafter of game lawfully taken, but not more than 30 ducks and 8 geese including brant may be possessed at any one time.

Interstate transportation: Export of all protected game (except rabbits and squirrels) prohibited; provided, during open season any licensee may, under his hunting license, take with him out of State, or as baggage on same conveyance, open to view, and plainly labeled with his name and address, not more than 2 days' limit of game lawfully taken by him. Any citizen of State may ship from State during open season as a gift and not for sale (which fact must be stated on shipping tag) one day's bag limit in one calendar week, if open to view and plainly labeled with names and addresses of donor and donee and number and kind of each so shipped.

Game taken outside of State and legally exported may be possessed in like manner as game taken in State.

Sale: Sale of all game prohibited, except of rabbits and squirrels during open season.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

Doves may not be shot on, at, or near any area on which salt, grain, or other food has been placed or scattered to attract them.

WASHINGTON

Open seasons:[40]	*Dates inclusive*
Deer (male), elk,[41] bear, rabbit, squirrel, and upland game birds, open seasons fixed by county game commissions.[40]	
Duck, goose (except Ross's goose and cackling goose), brant, coot	Nov. 16-Dec. 15.[42]
Wilson's snipe or jacksnipe	Oct. 1-Dec. 31.[42]
Rail other than coot	Oct. 1-Nov. 30.[42]

No open season:[40] Moose, elk (except as above); does, fawns, antelope, caribou, mountain sheep, mountain goats, and doves; Ross's and cackling geese, swans, wood duck, eider ducks, auklets, auks, bitterns, little brown and sand-hill cranes, fulmars, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, band-tailed pigeons, puffins, shearwaters, terns, and all shore birds (except Wilson's snipe or jacksnipe).[42]

Hunting and fishing licenses: Nonresident citizen or declarant residing in State less than 6 months: State, $25 (applicant from adjoining State pays same fees as charged resident of Washington by State of which he is a resident); game birds, $15; fishing: State, $5; county, $3. Resident (includes declarant residing in State six months): State: Game and fish, $7.50; fish, $5; game and fish, county, $1.50; guide, $10; taxidermist, $5. Resident special elk license (fee, $5) (issued to holder of State or county hunting and fishing license): Nonresident, $25 (issued to holder of State hunting and fishing license). Issued by county auditors. Alien: Hunting and fishing, State, $25 (issued only to holder of permit to carry firearms); fishing, county, $5. Professional guide (county), $10 (citizen only). Licensee must report number of game, fish, and fur animals taken in previous year before renewal of license. Fishing license not required of residents under 16.

Bag limits and possession: One deer, 1 elk, a season; 5 each of ruffed grouse, blue grouse, and Chinese or Mongolian pheasants, 10 each of quail and Hungarian partridges, a day or in possession, but a person desiring to possess more than one day's limit of upland game birds may do so by having each day's kill tagged that day by a game warden, and such tagged birds may be possessed during close season. Tagging fee, 10 cents for each bird, animal, or fish. Twenty ducks, geese, brant, Wilson's snipe a week (week ends at midnight Saturday), but not more than 4 geese, including brant, or 15 ducks a day; 30 ducks, geese, and brant (but not more than 8 geese, including brant), in possession; 25 coots, 25 sora, and 25 in all of other rails and gallinules but not more than 15 of any one species of rails (other than sora) and gallinules a day. Possession during close season permitted upon filing with county game commission description and number of each kind of game, which must be tagged or stamped by commission for identification, but rails may only be possessed until December 10 and other migratory game birds for 10 days after close of open season.

---

[38] Residents of States having larger nonresident angling license fee must pay fee charged nonresidents in own State.

[39] Battery, sinkbox, mat blind, or other floating device, or any boat or tender thereof, may not anchor, tie-out, or lie within 700 yards (except in North Bay, 200 yards) of any licensed blind or any blind on shore not licensed that is at any time occupied by the owner, or member or guest of any club owning same, for shooting therefrom.

[40] *Washington:* County game commission, with consent of supervisor of game and game fish, may shorten, close, or open season and fix bag limits on game and fur animals and upland game birds, as designated by statute. Communicate with county game commission at county seat, or supervisor of game and game fish, Box 384, Seattle.

[41] Unlawful at all times to kill elk in Clallam, Jefferson, Grays Harbor, and Mason Counties.

[42] Season on migratory game birds opens at 12 o'clock noon. No open season on waterfowl on Columbia or Snake Rivers or within a quarter of a mile of their shores in Benton, Columbia, Douglas, Franklin, Garfield, Grant, Kittitas, Klickitat, Walla Walla, Whitman, and Yakima Counties.

Interstate transportation: Export of all protected game prohibited, except that nonresident licensee may carry with him one day's limit of game birds upon attaching an affidavit that they were lawfully killed by himself and are not being exportep for sale.

Game taken outside of State when accompanied by affidavit of chief game official may be possessed at any time for noncommercial use, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Sale: Sale of all protected game prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

WEST VIRGINIA [43]

Open seasons:[43]	*Dates inclusive*
Deer (male, with branched horns) (see exception)	Dec. 1–Dec. 10.
Exception: In Marion, Marshall, Mercer, and Mingo Counties	No open season.
Rabbit (except on own land, at any time)	Oct. 15–Dec. 31.
Squirrel (except red squirrel, no close season)	Oct. 15–Nov. 30.[44]
Raccoon, opossum	Nov. 1–Jan. 31.
Ruffed grouse (pheasant), wild turkey, quail (Virginia partridge)	Oct. 15–Nov. 30.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 1–Oct. 31.[45]
Woodcock	Nov. 15–Dec. 15.[45]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 31.[45]
Rail (ortolan) and gallinule, other than coot	Sept. 1–Nov. 30.[45]

No open season: Elk (1935); does and fawns; doves, imported pheasants, Hungarian partridges, capercalzie, and other introduced foreign game birds; Ross's and cackling geese, swans, wood duck, bitterns, sand-hill cranes, grebes, gulls, herons, jaegers, loons, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Hunting and fishing, $15; fish, $5. Resident: Hunting and fishing, State, $3; county of residence and adjoining counties, $1. Issued by county clerk. License tag must be displayed between the shoulders on outer garment of licensee. Killing of deer must be reported to commission within 20 days. Aliens not permitted to hunt or fish, or to possess firearms. License not required of minors under 15. Landowner, his resident children and tenants, may hunt or fish on own land during open season without license. Unlawful to hunt or fish on lands of another without written permission of owner.

Bag limits and possession: One deer a season; 1 wild turkey a day, 2 a season; 6 rabbits a day, 40 a season, except rabbits killed on own premises; 6 squirrels a day, 30 a season; 8 quail a day, 50 a season; 3 ruffed grouse a day, 15 a season; 15 ducks, 4 geese, including brant, 4 woodcock, 20 Wilson's snipe, 25 coots, 25 sora, and 25 in all of other rails and gallinules, but not more than 15 of any one species of rails (other than sora) and gallinules a day. Not more than 30 ducks and 8 geese, including brant, may be possessed at any one time. Possession of migratory birds permitted during first 10 days of close season; other game legally taken may be possessed at any time.

Interstate transportation: Export prohibited of elk, deer, squirrels, quail, ruffed grouse (pheasant), wild turkeys, geese, brant, ducks, provided a nonresident licensee may personally take with him out of the State, during any open season, one day's limit of game animals or birds lawfully taken by himself.

Game taken outside of State and legally exported may be possessed at any time, except that migratory game birds may be possessed only during the open season where taken and first 10 days of close season.

Sale: Sale prohibited of all protected game except rabbits.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

WISCONSIN

Open seasons:	*Dates inclusive*
Deer (male, not less than 1 year old), in Polk, Barron, Chippewa, Clark, Marathon, Langlade, Oconto, and all counties north thereof (open in even, closed in odd years)	Nov. 21–Nov. 30.
In rest of State	No open season.
Rabbit (see exceptions)	Nov. 1–Jan. 1.
Exceptions: In Ashland, Barron, Bayfield, Burnett, Chippewa, Douglas, Florence, Forest, Iron, Langlade, Lincoln, Marathon, Marinette, Oconto, Oneida, Polk, Portage, Price, Rusk, Sawyer, Taylor, Vilas, Washburn, and Winnebago Counties	Oct. 1–Jan. 1.
In Monroe County	Nov. 1–Feb. 1.
In Outagamie County	Oct. 1–Nov 1.
In Crawford County	No close season.
Squirrel (see exception)	Nov. 1–Jan. 1.
Exception: In Dodge, Fond du Lac, Jefferson, Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties	No open season.
Duck, goose (except Ross's and cackling geese), brant, coot or mudhen	Oct. 1–Oct. 31.[46]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 20.[46]
Rails and gallinules, other than coot	Sept. 16–Nov. 30.[46]

No open season: Elk, moose, does and fawns, bear, quail, pheasants (Chinese, English, Mongolian); Hungarian partridges, prairie chickens or pinnated grouse, sharp-tailed grouse, partridges, spruce hens, doves, woodcock, swans, Ross's goose, cackling goose, wood duck, eider ducks, auks, bitterns, little brown, sand-hill, and whooping cranes, grebes, guillemots, gulls, herons, loons, murres, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: All game, $50; all game (except deer), $25; fish, $3 (3 shipping coupons, $2 additional); fishing license not required of persons under 16; settler, $1 (deer tag, $1); guide, $1. Issued by commission. Resident: Game, $1 (deer tag, $1 additional); issued by county clerks. Licensees are required to submit, on or before Feb. 1, an annual game census report on form furnished with license.

Hunting licenses not issued to persons under 15 or to aliens. Hunting prohibited in fields of growing grain or on lands of another without consent of owner.

Bag limits and possession: One male deer in even years (1932); 5 squirrels a day; 5 rabbits a day (except in Crawford County, no limit); 4 geese, including brant, a day. Ducks (including coot or mud hen), 15 a day; snipe, rail, rice hen, gallinule, 15 a day, but not more than 25 in all of rails (other than sora) and gallinules a day.

---

[43] *West Virginia:* Commission by order may change, modify, or suspend open season, or change the bag limit on any game.

[44] Commission, on petition of 150 licensed hunters in any county, may open squirrel season in such county not earlier than Sept. 1 and close season at a correspondingly earlier date.

[45] Season on migratory game birds opens at 12 o'clock noon.

[46] *Wisconsin:* Season on migratory game birds opens at 12 o'clock noon. Ducks and coots or mud hens may not be hunted on Wednesday of each week during open season.

Possession at any time of deer duly tagged permitted for private use by person killing it.

Possession in excess of one day's bag limit prohibited.

Possession at any time prohibited of game by person without hunting license or scientist's certificate.

Interstate transportation: Export of all protected game prohibited, except that nonresident licensee may transport, between November 21 and November 30, inclusive (1932), 1 deer duly tagged, if he accompanies shipment and may take in his personal possession, openly, a mixed bag of not more than 20 game birds legally killed, but not more than the bag limit for one day of any one variety.

Game taken outside of State and legally exported may be possessed as authorized by permit from conservation commission, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season.

Sale: Sale of all protected game prohibited (except rabbit). Rabbits may be sold during open season.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

WYOMING

Open seasons:[47]	*Dates inclusive*
Deer (male, with forked horns) (see exceptions)	Sept. 15–Nov. 15.
Exceptions: In Albany, Campbell, Carbon, Johnson, Natrona, Platte, Sheridan, and Sweetwater Counties	Oct. 1–Oct. 15.
In Hot Springs and Washakie Counties	Oct. 16–Oct. 31.
In Big Horn County	Oct. 20–Oct. 31.
In Converse, Goshen, Laramie, and Niobrara Counties	No open season.
In Lincoln, Sublette, and Uinta Counties	Oct. 1–Nov. 15.
In Crook and Weston Counties	Oct. 15–Nov. 15.
Elk (see exceptions)	No open season.
Exceptions: In Albany and Carbon Counties	Oct. 1–Nov. 30.
In Big Horn County	Oct. 20–Oct. 31.
In Fremont, Park, and Teton Counties	Sept. 15–Nov. 15.
In Sheridan County	Oct. 1–Oct. 31.
In Lincoln, Sublette, and Uinta Counties	Oct. 1–Nov. 15.
Bull moose[48] (see exceptions)	No open season.
Exceptions: In parts of Fremont, Park, and Teton Counties	Sept. 15–Nov. 15.
In parts of Lincoln and Sublette Counties	Oct. 1–Nov. 15.
Male mountain sheep (see exceptions)	No open season.
Exceptions: In Park County	Sept. 15–Nov. 15.
In Lincoln and Sublette Counties	Oct. 1–Nov. 15.
In Teton County	Oct. 15–Oct. 31.
Sage hen, or sage chicken (see exception)	Aug. 16–Aug. 18.
Exception: In Carbon, Goshen, Laramie, Sheridan, and Teton Counties	No open season.
Grouse (see exceptions)	No open season.
Exceptions: In Crook, Platte, and Weston Counties	Sept. 1–Sept. 30.
In Fremont County	Oct. 1–Nov. 15.
In Campbell, Johnson, and Sheridan Counties	Sept. 15–Oct. 14.
In Lincoln, Sublette, and Sweetwater Counties	Oct. 1–Nov. 15.
In Park and Teton Counties	Sept. 15–Nov. 15.
Duck, goose (except Ross's goose and cackling goose), brant, coot	Oct. 1–Oct. 31.[49]
Wilson's snipe or jacksnipe	Oct. 1–Dec. 16.[49]

No open season: Antelope; buffalo; does and fawns; pheasants, quail, Hungarian partridges, prairie chickens (1930); doves, swans, Ross's and cackling geese, wood duck, rails, gallinules, bitterns, little brown and sandhill cranes, grebes, gulls, herons, loons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: General hunting and fishing, $60 (not issued to minors under 16); game birds, $10 (not issued to minors under 16); fishing, $4 (not issued to minors under 14). Nonresident hunting big game must be accompanied by a guide, except that two persons may accompany one guide. Nonresident special elk license, $40 (not required where nonresident general license has been procured). Nonresident, special mountain sheep license, $15. Nonresident, special bear permits, $25 (authorizes killing of 3 bears). Resident: General hunting and fishing, $5 (not issued to minors under 16); game birds, $2 (not issued to minors under 13); fishing, $1.50 (not required of Civil War veterans or minors under 16). Resident, special elk and special deer licenses, $2.50 each, and mountain sheep, $5, but not required where general hunting and fishing licenses have been procured. Guide license, citizen only, $25 (bond, $500). Permit to photograph game or birds January 1 to April 30, inclusive, under supervision of commission, $5. Taxidermist, $10. Resident alien, fishing, $7.50; resident alien, game bird, $10. Nonresident alien, fishing, $12.50. Alien licenses not issued to minors under 14. Hunting predatory animals or bears in national forests, fee $1 for each dog. Licenses and permits issued by State game and fish commissioner, his chief assistant, chief clerk, assistant and deputy game and fish commissioners, superintendents of fish hatcheries, justices of the peace, and persons authorized by State game and fish commission. Unlawful to hunt on inclosed lands of another without permission.

Bag limits and possession: One deer, 1 elk, 1 mountain sheep, 1 bear a season; under special permits,[48] 1 bull moose, 1 antelope, 3 bears (nonresident), a season; possession limited to 15 game birds, of which not more than 6 may be sage hens, sage chickens, or grouse. Federal limits on killing migratory game birds: 15 ducks, 4 geese, including brant, 20 Wilson's or jacksnipe, 25 coots, a day. Not more than 30 ducks and 8 geese, including brant, may be possessed at any one time.

Interstate transportation: Export of all protected game prohibited, provided game may be exported if properly tagged by a justice of peace, assistant or deputy commissioners, or superintendents of fish hatcheries; fee, 50 cents. Game tags issued under affidavit that game was lawfully killed, and, if for edible portion, that it is not for sale. Not more than 30 ducks, 8 geese, including brant, 40 Wilson's snipe; 50 coots or 50 in all of rails and gallinules but not more than 30 of any one species may be exported by one person in any one calendar week.

Game taken outside of State and legally exported may be possessed at any time, except that migratory game birds may be possessed only during open season where taken and first 10 days of close season. Person possessing game during close season in State, must show lawful taking.

Sale: Sale of all game of State prohibited, except edible portion when properly tagged. Justices of the peace, assistant and deputy commissioners, or superintendents of fish hatcheries issue tags (fee 50 cents) under affidavit of lawful killing. Sale of migratory birds prohibited.

Miscellaneous: Federal regulations do not permit the use of more than 10 live goose decoys at any one stand or blind in the hunting of wild geese.

---

[47] *Wyoming:* State game and fish commission may suspend open season in any county or district of State on any species of game when threatened with extinction.

[48] Commission may issue not to exceed 50 permits for bull moose. **Fees: Resident citizen, $50;** nonresident or noncitizen, $100; limit, 1 a season.

[49] **Season on migratory game birds opens at 12 o'clock noon.**

CANADA

ALBERTA

Open seasons: [50] [51]	*Dates inclusive*
Deer (see exception), moose, caribou (must have horns at least 4 inches long)	Nov. 1–Dec. 14.[51] [52]
Exception: Deer, south of North Saskatchewan River, and east of Canadian Pacific Railway from Edmonton to Macleod	No open season.
Mountain sheep (male), mountain goat (must have horns at least 4 inches long)	Sept. 1–Oct. 31.
Bear (except cubs or bear with cub)	Sept. 1–June 14.
Sharp-tailed grouse, north of Red Deer River only	Oct. 1–Oct. 15.
European gray partridge (Hungarian partridge)	Oct. 1–Nov. 15.
Duck, goose, Wilson's snipe or jacksnipe, coot, gallinule:	
North of Clearwater and Athabaska Rivers	Sept. 1–Nov. 14.
South	Sept. 15–Nov. 14.

No open season: Antelope, elk or wapiti, buffalo; females of deer, moose, mountain sheep, young of all big game with horns less than 4 inches in length; grouse (except sharp-tailed grouse north of Red Deer River), partridges, prairie chickens, ptarmigan; pheasants, doves, swans, wood duck, rail, bitterns, little brown, sand-hill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting licenses: Nonresident: General, $50; bird, $5. Resident: Big game, $1; bird, $2.25, not required of farmer or member of family residing with him on farm nor of residents residing north of fifty-fifth parallel; guide, $2.50 (guide may not act for more than three persons on any trip). Special license: Nonresident, $50; resident, $5 (issued to holders of general licenses and authorizes taking of deer, moose, and caribou in Rocky Mountain Forest Reserve of Alberta, north of North Saskatchewan River, Sept. 1 to Oct. 31, inclusive). Taxidermist, $5. Issued by minister of agriculture. Consent of owner or occupant required for hunting on inclosed lands of another.

Bag limits and possession: Deer, moose, caribou, mountain sheep, mountain goat, bear, 1 of each species a season; sharp-tailed grouse, 5 a day, 25 a season; Hungarian partridges, 15 a day, 75 a season; 15 ducks a day during September, 25 a day rest of season; 100 a season; 10 geese a day, 30 a season; 25 coots, 25 Wilson's snipe, a day. Migratory game birds legally taken during the open season may be possessed until March 31.

Export: Export of all protected game prohibited, except that minister of agriculture may grant permits for export of game at rate of $5 for each head of big game and $1 a dozen for game birds. The holder of a general nonresident license may take with him out of Province as trophies, heads, skins, and hoofs of big game legally killed by him. Any person may export mounted or branded heads at a fee of $1 a head. Export of migratory birds prohibited during close season.

Sale: Sale of migratory game birds and flesh of all other game prohibited. Heads of big game before being sold must be stamped by minister of agriculture at fee of $5 for elk, caribou, moose, mountain sheep, and $2 each for deer and mountain goat.

BRITISH COLUMBIA

Open seasons: [53]	*Dates inclusive*
Bull moose, in Atlin, Fort George, Cariboo, and Omineca electoral districts and Kamloops electoral district north of fifty-first parallel	Sept. 1–Dec. 15.
In Columbia electoral district	Sept. 15–Oct. 31.
Bull caribou, in eastern district [54] except in Mackenzie and Skeena electoral districts, Cariboo electoral district west of Fraser River, and except south of main line Canadian Pacific Railway	Sept. 1–Dec. 15.
Bull elk (wapiti) in Fernie and Columbia electoral districts (except west of Columbia River in Columbia electoral district)	Sept. 15–Oct. 15.
Male mountain sheep, in eastern district north of Canadian National Railway and in Cariboo and Lillooet electoral districts south of the main Chilcotin River, and west of Fraser River, and in Fernie, Cranbrook, and Columbia electoral districts	Sept. 1–Nov. 15
Mountain goat in eastern district (except North and South Okanagan, and Grand Forks-Greenwood electoral districts)	Sept. 1–Dec. 15.
In western district [54] (except Vancouver Island)	Sept. 12–Dec. 15.
Male deer (mule, white-tail, coast) in eastern district [54] (see exception)	Sept. 12–Dec. 15.
Exception: White-tailed deer in North and South Okanagan and Similkameen electoral districts and west of summit of Midway Mountains in Grand Forks-Greenwood electoral district	No open season.
In western district [54] (see exceptions)	Sept. 12–Dec. 15.
Exceptions: Bucks only, in North and South Saanich and Highland districts on Vancouver Island	Sept. 12–Oct. 31.
Deer on Queen Charlotte Islands	No open season.
Bear (except white or Kermodei bear) in eastern district [54]	Sept. 1–June 30.
In western district [54]	Sept. 12–June 30.
Band-tailed pigeon, in western district only [54]	Sept. 15–Oct. 15.

---

[50] *Alberta:* Seasons on game birds fixed by lieutenant governor in council and may be obtained from game commissioner, Edmonton. Season on migratory game birds opens at 12 o'clock noon.

[51] Resident north of fifty-fifth parallel, when necessary to provide food for his family, may kill big game (other than buffalo and elk) and scoters.

[52] Deer, moose, and caribou (big game must have horns at least 4 inches long), open season under special license in Rocky Mountain Forest Reserves of Alberta, Sept. 1 to Oct. 31, inclusive (see Hunting licenses).

[53] *British Columbia:* Regulations prescribing seasons, bag limits, and restrictions on sale of upland game birds for season 1931–32 are adopted by lieutenant governor in council. Full information may be had from provincial game commissioner, Vancouver.

[54] *Western district* includes that portion of Province west of summit of Cascades and south of Atlin electoral district, and, in the case of migratory birds, excluding that portion of Lillooet electoral district east of the easterly railway yard limit of Alta Lake railway station on Pacific Great Eastern Railway, and that portion of Skeena electoral district east of easterly railway yard limit of Shames on Canadian National Railway, bounded on the north by Atlin electoral district and on the south by Maitland Island. *Eastern district* includes rest of Province.

Open seasons—Continued.	*Dates inclusive*
Duck, goose, brant, coot, Wilson's snipe or jacksnipe; eastern district [54] (see exceptions)	Sept. 15-Dec. 31.
Exceptions: In Creston electoral district	Sept. 15-Nov. 30.
In Atlin, Omineca, and Fort George electoral districts, and that part of Skeena electoral district lying in the eastern district [54]	Sept. 1-Dec. 15.
Duck, goose, coot, Western district [54]	Oct. 17-Jan. 31.
Wilson's snipe or jacksnipe, western district [54]	Oct. 15-Jan. 31.
Black brant: Western district [54]	Nov. 15-Feb. 28.

No open season: Buffalo; young of mountain goats; moose, caribou, elk, deer, except as above; and mountain sheep, except males over 1 year of age as above; rail, swans, wood duck, little brown and sand-hill cranes, auklets, auks, bitterns, fulmars, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except Wilson's snipe).

Hunting and fishing licenses: Nonresident: General, $25 and $25 additional for each grizzly bear, moose, mountain sheep, wapiti, or caribou, $15 additional for each black or brown bear, mountain goat, or mule deer, and $5 additional for every deer of any other species shot by him; angling, season $10; British subject, birds $5 a week. Resident British subjects or farmers as defined under game act, and members of army, navy, air forces, or militia on duty in Province: Deer and birds, $2.50; big game and birds, $5. Big game, birds, and trapping, $10 (holder must report within 2 months after expiration of license number of big game or fur animals taken); resident alien, $10 (big game and game birds only); guide, $5; taxidermist, $5. Issued by warden or any person authorized by him.

No fee required of farmer holding more than 10 acres of land or members of family for license to hunt birds and deer during open season on land on which he resides. Free license granted to resident prospector under certain conditions upon production of free miner's certificate. No license issued to person under 18 without written consent of parent or guardian, and then to hunt with firearms only under supervision of licensed adult. Unlawful to hunt on cultivated, cleared, or inclosed land without owner's consent.

Badge to be worn by licensee. Firearms not to be carried without license.

Bag limits and possession: One moose, 2 caribou (except in eastern district south Canadian National Railway, limit 1), 1 elk (wapiti), 2 mountain sheep (except in Fernie, Cranbrook, Columbia electoral districts, and in Cariboo and Lillooet electoral districts, south of main Chilcotin River and west of Fraser River, limit 1), 2 mountain goats, 2 deer in eastern district, 3 in western district, 2 grizzly bears, 3 bears of any other species a season; 10 band-tailed pigeons a day, 50 a season; 20 ducks a day, 150 a season; 10 geese a day, 50 a season; 10 brant a day, 50 a season; 25 Wilson's snipe a day, 150 a season; 25 coots a day, 150 a season. (Limits on other species of game fixed by regulations of lieutenant governor in council.) Game may be possessed for 2 weeks after close of open season. Unlawful for a dealer in skins to possess the skin of any wapiti (elk) or deer.

Export: Export prohibited of all game except under permit of provincial game warden.

Sale: Sale of migratory game birds prohibited and of all other game, except under regulations of lieutenant governor in council; provided, bull moose and bull caribou may be sold in Atlin and Omineca electoral districts from September 1 to December 15, and bears (except white or Kermodei bears) in eastern district from September 1 to June 30, and in western district from September 12 to June 30.

MANITOBA

Open seasons: [55]	*Dates inclusive*
Deer, moose, caribou, or reindeer (males)	Dec. 1-Dec. 10.
Prairie chicken, grouse, Hungarian partridge (2 days)	Oct. 15, 16.
Ptarmigan	Oct. 1-Oct. 20.
Duck, coot, north of fifty-third parallel	Sept. 1-Nov. 30.
Geese, Wilson's snipe or jacksnipe, north fifty-third parallel	Sept. 15-Nov. 30.
Duck, south fifty-third parallel	Oct. 1-Nov. 14.
Geese, Wilson's snipe or jacksnipe, coot, south fifty-third parallel	Sept. 15-Nov. 30.

No open season: Bison or buffalo, elk or wapiti, antelope or cabri, females and young of big game; doves, partridges, quail, pheasants, introduced game birds; rail, swans, wood duck, eider ducks, woodcock, bitterns, little brown, sand-hill, and whooping cranes, grebes, gulls, herons, jaegers, loons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting licenses: Nonresident alien, big game, $40; birds, $25. Nonresident British, big game, $25; birds, $10. Resident, big game, $5; birds, $2. Issued by director of game and fisheries, department of mines and natural resources. License to hunt deer not issued after November 30. Hunting prohibited on inclosed or cultivated land or land covered by buildings or water, without consent of owner. No license required of farmers or members of family to hunt on farm of 40 acres or more on which they reside. Holder of resident bird license required, on or before December 15, to return license with sworn statement that he has not violated the act.

Bag limits and possession: One in all of deer, moose, and caribou a season; 10 in all of Prairie chicken, grouse, and Hungarian partridge; 15 ptarmigans a day, 50 a season; 15 ducks a day in September, 30 a day in October and November, 150 a season; 10 geese a day, 50 a season; 25 coots, and 25 Wilson's snipe a day. Possession of ptarmigans allowed for 10 days after close of hunting season and of migratory game birds until March 31. Venison for private use may be possessed at any time on proof of legal killing. Heads and hides of big game legally taken, within or without Province, may be possessed at any time.

Export: Export prohibited of all protected game, except under permit issued by department of mines and natural resources. No permit may be issued for export of ptarmigans, geese,ducks, or entire carcass of any moose, caribou, or deer; provided, nonresident licensee under permit issued free may export carcass of moose, caribou, or deer, and not more than 10 geese and 50 ducks killed by him. (No ducks may be exported before Oct. 1.) Export of migratory birds prohibited during close season.

Sale: Sale of all protected game prohibited except heads and hides of big game.

Miscellaneous: Big-game hunter must wear complete outer suit and cap of white material.

NEW BRUNSWICK

Open seasons:	*Dates inclusive*
Deer (see exception)	Oct. 1-Nov. 30.
Exception: On Grand Manan Campobello, and Deer Island	No open season.[56]
Bull moose (antlers must have 10 points)	Oct. 1-Nov. 30.
Partridge (see exception)	Oct. 1-Oct. 15.
Exception: On Grand Manan, Campobello, and Deer Island	No open season.

---

[54] See footnote on p. 44, col. 2.

[55] *Manitoba:* Open season may be shortened or closed or bag limits reduced by order-in-council.

[56] *New Brunswick:* Minister of lands and mines may issue license (fee, $1) to resident of Grand Manan, Campobello, or Deer Island to take 1 deer, Oct. 15-Nov. 15.

Open seasons—Continued.	*Dates inclusive*
Duck, goose, brant, rail, coot, gallinule (see exception)	Sept. 15–Dec. 31.
Exception: Islands in Grand Manan group	Oct. 15–Jan. 31.
Woodcock, jacksnipe or Wilson's snipe (see exception)	Oct. 1–Nov. 30.
Exception: Islands in Grand Manan group	Oct. 15–Nov. 30.

No open season: Caribou (Oct. 1, 1940); calf moose under 3 years and cow moose; pheasants, swans, wood duck, auks, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Big game, $50 (1 bull moose, 2 deer, 2 bears); $25 (2 deer); special license, $25 (2 bears, Apr. 1–June 30); bird, $25; trout, season, $10; salmon, season, $25; special 3-day trout and salmon, $5. Resident: Big game: $3 (1 bull moose, 2 deer); $2 (2 deer); bird, $1; taxidermist, $1; guide, $1; camp help, $1. Special license for salmon in reserved waters of the Restigouche: Nonresident, $25 a day; resident, $5 a day. Issued by minister of lands and mines and authorized vendors. Resident big-game licensees must report number of game animals killed thereunder not later than December 10. Big-game license not issued to person under 18. Nonresident licensee must have registered guide, and not more than two hunters may accompany one guide.

Bag limits and possession: Two deer, 1 moose (lumber camp limited to 2 moose and 4 deer) a season; 6 partridges a day, 20 a season; 15 ducks a day, 150 a season; 15 geese, 15 brant, 25 in all of rails, coots, gallinules, and 25 Wilson's snipe a day; 8 woodcock a day, 125 a season. Game may be kept for personal use in cold storage during close season under permit, but migratory game birds may not be possessed after January 31 except in Grand Manan group they may be possessed until the last day of February.

Export: Export of all game prohibited, except game killed by nonresident licensee may be exported within 15 days after being killed, under permit from Canadian customs office.

Sale: Sale of all game prohibited. Hides and skins of animals may be sold under license by nonresidents or aliens, fee, $25, and residents, fee, $5.

NORTHWEST TERRITORIES [57]

Open seasons:	*Dates inclusive*
Deer and moose (males only), mountain goat	Sept. 1–Mar. 31.
Mountain sheep, caribou	Sept. 1–Feb. 28.
Partridge, prairie chicken, ptarmigan, and other grouse	Sept. 1–Dec. 31.
Duck, goose, brant, rail, coot, gallinule, Wilson's snipe	Sept. 1–Dec. 14.

No open season: Buffalo or bison; musk-oxen, wapiti or elk, does; females of moose, caribou, mountain sheep, and mountain goats with young and young of any such animals; swans; auks, bitterns, little brown and sand-hill cranes, fulmars, grebes, guillemots, gulls, jaegers, loons, murres, terns, and all shore birds (except Wilson's snipe or jacksnipe). Arctic Islands Preserve, Peel River, Yellowknife, and Slave River Preserves, reserved as exclusive hunting and trapping grounds for native Indians, Eskimos, and half-breeds. All hunting prohibited in Thelon Game Sanctuary.

Hunting and trapping licenses: Nonresident, $150. Nonresident British subject: General, $75; game birds, $5. Resident, $2. Trading or trafficking in game: Nonresident, $300; nonresident British subject, $150; resident, $5. Issued by director of Northwest Territories. Permit from commissioner required to establish trading post. Licensee, before leaving Territory, or as soon as practicable after expiration of license, must return license to nearest game officer or warden with a statement of number of each kind of game killed, or trafficked in. Native-born Indians, Eskimos, or half-breeds bona-fide residents of Northwest Territories may hunt without a license.

Bag limits and possession: Twenty-five ducks, 15 geese, 15 brant, 25 in all of rails, coots, and gallinules, and 25 Wilson's snipe a day. Migratory game birds legally taken during open season may be possessed until April 14.

Export: Export of the meat or the raw skins of game animals prohibited, except under permit from minister or authorized officer.

Sale: Sale of migratory game birds during close season and of all other game illegally taken prohibited.

NOVA SCOTIA

Open seasons:	*Dates inclusive*
Bull moose (except on Cape Breton Island, no open season), deer (male only on Cape Breton Island)	Oct. 16–Nov. 15.[58]
Hare, rabbit	Nov. 1–Feb. 29.
Ruffed grouse (see exception)	Oct. 16–Oct. 31.
Exception: On Cape Breton Island	Nov. 1–Nov. 15.
Duck, goose, brant, rail, coot, gallinule (see exceptions)	Oct 1–Jan 15.
Exceptions: Goose, brant, in Halifax, Shelburne, and Queens Counties (license required)	Dec. 1–Feb. 14.
Duck, rail, in Colchester and Cumberland Counties	Sept. 15–Dec. 31.
Woodcock, Wilson's snipe or jacksnipe	Oct. 1–Nov. 30.

No open season: Caribou, does on Cape Breton Island, cow moose, and young of deer and moose under 2 years of age; Canada grouse (spruce partridges), Hungarian partridges, pheasants, swans, wood duck, auks; bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting licenses: Nonresident or alien: All game, $50; birds and small game, except woodcock and snipe, $15; woodcock and snipe, $25. Resident: Big game, $2; guide, $2. Taxidermist, $5. Issued by minister of lands and forests and agents. Licenses not issued to persons under 18.

Bag limits and possession: Two deer (either sex, except on Cape Breton Island, 1, male only); 1 moose, season; 5 ruffed grouse a day, 10 a season; 15 ducks, 15 geese, 15 brant, 25 in all of rails, coots, and gallinules, 25 Wilson's snipe a day; 8 woodcock a day, 125 a season. The green hide or fresh meat of moose and deer may be possessed Oct. 16 to Nov. 20, and migratory game birds legally taken during open season may be possessed for one month after close of open season, except geese may be possessed until the last day of February in Halifax, Queens, and Shelburne Counties.

Export: Export prohibited of all protected game except that holder of nonresident general license may ship out of Province under license tag 1 moose lawfully shot by himself.

Sale: Sale of deer, moose, caribou, pheasants, black cock, capercailzie, Canada grouse (spruce partridge), chukar partridges, ruffed grouse, Hungarian partridges, and all migratory game birds prohibited. Rabbits may be sold Nov. 1 to Mar. 1.

---

[57] "*Northwest Territory* means the northwest territories formerly known as Rupert's Land and the northwestern territory (except such portions thereof as are included in Provinces of Ontario, Quebec, Manitoba, Saskatchewan, and Alberta and Yukon Territory), together with all British territories and possessions in North America and all islands adjacent thereto not included within any Province, except Colony of Newfoundland and its dependencies."

[58] *Nova Scotia:* Every person killing a deer or moose must, within 10 days, make a written and signed report to minister showing his address, when and where such animal was killed, and its sex.

ONTARIO

Open seasons:[59]	*Dates inclusive*
Deer, bull moose, north of main line Canadian National Railway, between Quebec and Manitoba boundary lines	Sept. 15–Nov. 25.
South of Canadian National Railway to Mattawa River and Canadian Pacific Railway to Heron Bay, north shore Lake Superior, and south of Canadian National Railway	Oct. 20–Nov. 25.
South Canadian Pacific and Heron Bay and north Lake Nipissing and French River (see exception)	Nov. 1–Nov. 25.
Exception: On St. Joseph Island, Algoma district	Nov. 10–Nov. 25.
South of French and Mattawa Rivers (except in Carleton, Dundas, Glengarry, Grenville, Leeds, and Stormont Counties, and in Bruce, Grey, Simcoe, and York Counties, and territory south and west thereof no open season)	Nov. 5–Nov. 20.
Hare	No close season.
Woodcock	Sept. 15–Nov. 30.
Duck, goose, brant, Wilson's snipe or jacksnipe, rail, coot, gallinule:	
North and west of French and Mattawa Rivers and in all Georgian Bay waters (see exception)	Sept. 1–Dec. 15.[60]
Exception: Eider duck, north of Quebec, Cochrane, Winnipeg line of Canadian National Railway, only	Sept. 1–Dec. 15.
South of French and Mattawa Rivers, but not including Georgian Bay waters	Sept. 15–Dec. 15.

No open season: Caribou, cow and calf moose and moose under 1 year of age; black or gray squirrels, quail, ruffed grouse or partridges, pheasants or prairie fowl, wild turkeys; doves, swans, wood duck,[60] eider duck (except as above), auks, bitterns; little brown, sand-hill, and whooping cranes; gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, terns, and all shore birds (except woodcock and Wilson's snipe).

Hunting and fishing licenses: Nonresident: Game, $41; game birds and rabbits, $21; angling, $5.50; special, $10.50 (weekly license, for Lake Nipigon, Frazier Creek, and Nipigon River, north and west of Lake Helen); not required of children under 12 when accompanied by licensed nonresident, but catch is included in daily limit of such licensee. Resident, moose, $6; deer, $4; camp license, $4 (allows 1 deer to 6 residents for food in camp); game, $2 (required only in Brant, Elgin, Essex, Haldimand, Halton, Kent, Lambton, Lincoln, Middlesex, Norfolk, Oxford, Peel, Perth, South Huron, South Wellington, Waterloo, Welland, Wentworth, and York Counties); angling, special, $5.50 (good for 2 weeks in Lake Nipigon, Frazier Creek, and Nipigon River north and west of Lake Helen). Guide, $2. Issued by department of game and fisheries.

Bag limits and possession: One deer, 1 bull moose, a season; 15 ducks a day, 150 a season; 15 geese, 15 brant; 25 in all of rails, coots, and gallinules, and 25 Wilson's snipe a day. Eight woodcock a day, 125 a season; two or more persons hunting together under license may kill an average of 1 deer each. Possession of all game legally taken permitted during open season and until Mar. 31.

Export: Export of all wild game animals and birds prohibited; provided, 1 deer, 50 ducks, 1 bull moose, and under export permit bears or bear pelts, may be exported under nonresident hunting license if shipping coupon and, if required, affidavit of lawful killing be attached and contents of packages be open to view. Minister may issue permit for export of game, dead or alive, at any time, except migratory birds during close season.

Sale: Sale or purchase of deer, moose, migratory game birds, quail, grouse, introduced pheasants, and Hungarian partridges prohibited.

Miscellaneous: Use of automatic shotgun prohibited.

PRINCE EDWARD ISLAND

Open seasons:	*Dates inclusive*
Hare, rabbit	Nov. 1–Feb. 1.
Partridge (open in odd, closed in even years)	Oct. 15–Nov. 15.
Duck, goose, brant, rail, coot, gallinule	Sept. 1–Dec. 14.
Woodcock, jacksnipe or Wilson's snipe	Sept. 15–Nov. 30.

No open season: Pheasants, swans, wood duck, bitterns, little brown cranes, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe or jacksnipe).

Hunting and fishing licenses: Nonresident: Game. Fee, $5; sons, brothers, and sisters of residents returning for visit, $2.50; guest permit fee, $2.25 per week. Issued by game inspector or justice of peace. Hunting on inclosed lands without permission of owner prohibited. Nonresident, angling fee, $2 (not required of son, daughter, sister, or brother of a permanent resident of Province). Issued by Provincial treasurer or game inspector.

Bag limits and possession: Three partridges a day; 15 ducks, 15 geese, 15 brant, 25 in all of rails, coots, and gallinules, and 25 Wilson's snipe a day; 8 woodcock a day, 125 a season. Migratory game birds legally taken in open season may be possessed until January 31.

Export: Export prohibited of all game, provided, nonresident licensee may carry out of Province 12 birds killed by himself if tagged and carried open to view. Export of migratory birds prohibited during close season.

Sale: Game lawfully killed (except migratory birds) may be sold during open season.

QUEBEC

Open seasons:	*Dates inclusive*
Bull moose (see exception)	Sept. 10–Dec. 31.
Exception: South of St. Lawrence River	Sept. 20–Dec. 31.
Deer	Sept. 1–Nov. 30.
Hare	Oct. 15–Jan. 31.
Bear	Aug. 20–June 30.
Birch or spruce partridge	Sept. 1–Dec. 15.
White partridge or ptarmigan	Nov. 1–Jan. 31.
Duck, goose, brant, rail, coot, gallinule, woodcock, jacksnipe or Wilson's snipe	Sept. 1–Dec. 15.

No open season: Caribou, cow moose, young of deer and moose, swans, wood duck, eider ducks, auks, bitterns, fulmars, gannets, grebes, guillemots, gulls, herons, jaegers, loons, murres, petrels, puffins, shearwaters, terns, and all shore birds (except woodcock and Wilson's snipe).

Hunting licenses: Nonresident: General, $25 (members of incorporated hunting clubs, $10). Resident, not British subject, $5; resident, deer, $1, moose, $1. Resident British subject not hunting for own use must obtain special license. Issued by minister of colonization.

Bag limits and possession: Two deer, 1 moose, a season; 25 ducks, 15 geese, 15 brant, 25 in all of rails, coots, and gallinules, and 25 Wilson's snipe a day; 8 woodcock a day, 125 a season. Migratory game birds legally taken during open season may be possessed until Mar. 31, and others during first 15 days of close season.

Export: Export of moose and deer, or parts thereof, prohibited, except nonresident licensee may take out game animals killed by himself, under customs declaration and approval of Canadian collector of customs; export of grouse or partridges and of migratory birds prohibited during close season. Big game lawfully taken and coming from without Province may be transported under permit issued by minister of colonization.

---

[59] *Ontario:* Lieutenant governor in council may alter current close season on any game animal or bird diminished in numbers.

[60] Lieutenant governor in council may permit the taking of wood ducks under special regulations.

Sale: Sale of deer and moose or any part thereof, and of all migratory game birds (except ducks during the open season) prohibited; also spruce partridges until October 15, 1935. Other game lawfully taken may be sold from the third day of open season to and including the fifteenth day after expiration of open season. Licensed hotels, restaurants, and clubs may serve meat of hares, bears, ducks, and ptarmigan lawfully taken.

SASKATCHEWAN

Open seasons:[61]	*Dates inclusive*
Deer, moose (males only), caribou (see exception)	Nov. 15–Dec. 14.
Exception; South of Township 35	No open season.
Hungarian partridge	Oct. 1–Oct. 31.
Prairie chicken or sharp-tailed grouse, prairie hen or pinnated grouse	Oct. 1–Oct. 15.
Duck, goose—	
North of Township 54	Sept. 1–Sept. 30.
South of Township 55	Sept. 15–Oct. 15.
Wilson's snipe or jacksnipe, coot	Sept. 15–Dec. 31.

No open season: Antelope, buffalo, elk, and females of big game other than caribou, and young of big game under 1 year of age.[62] Sage grouse, ruffed grouse, partridge, Canada grouse, spruce grouse, ptarmigan, rail, swans, wood duck, bitterns, little brown, sand-hill, and whooping cranes, grebes, gulls, herons, loons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting licenses: Nonresident alien: Big game, $50; birds, $25; nonresident domiciled in Canada: Big game, $25; birds, $10; issued by minister of railways, labor, and industries. Resident: Big game, $5; birds, $1.50; issued by minister or agent. Bird license not required of residents hunting on land outside city, town, village, or hamlet on which they are actually domiciled. No license issued to person under 16 without written consent of parent or guardian. Big-game hunters must wear white suit and cap and immediately after close season must return license with report of number and sex of animals killed. Hunting prohibited on inclosed lands without consent. Taxidermist, $5.

Bag limits, and possession: One moose, 2 deer, 1 caribou or 1 caribou and 1 deer a season; 10 Hungarian partridges a day, 30 a season; 5 sharp tailed or pinnated grouse a day; 10 in possession; 15 ducks, 5 geese, a day first 2 weeks of season; 30 ducks, 5 geese, a day rest of season, but not more than 2 days limit of each in possession at any time; 25 coots a day, 150 a season; 15 Wilson's snipe a day, 150 a season. Game birds may be kept in licensed storage from Sept. 16 to last day of February, and flesh of big game from Dec. 1 to Apr. 1, if tagged with number and kind of game, name of depositor, and number of his hunting license. Licensed hunters must report number of big game and game birds killed.

Export: Export of all protected game prohibited; provided, nonresident licensee on leaving Province may take with him during open season personally under his license coupons and permit, big game and 100 game birds legally killed. Export of migratory birds prohibited during close season. Minister may issue permits to export deer (fee, $2 a head) or other big game (fee, $5 a head), hides of big game (fee, $1 each), flesh of big game (fee, $1 each 20 pounds or less); birds (fee, $1 a dozen; limits, 5 dozen ducks, 1 dozen geese, a season). No permit may be issued for the entire carcass of a moose, caribou, or other deer, and no person may export in one season more than 60 ducks or geese.

Sale: Sale of migratory game birds and flesh of all other protected game prohibited.

YUKON

Open seasons:[63]	*Dates inclusive*
Deer, moose, caribou, mountain sheep, mountain goat (males only)	Aug. 1–Mar. 1.
Partridge, prairie chicken, grouse, ptarmigan, pheasant	Sept. 1–Mar. 15.
Duck, goose, brant, rail, coot, gallinule, Wilson's snipe or jacksnipe	Sept. 1–Dec. 14.

No open season: Moose or caribou under 1 year of age; elk or wapiti, musk-oxen, bison or buffalo, and females of other big game; swans, cranes, grebes, gulls, jaegers, loons, terns, and all shore birds (except Wilson's snipe or jacksnipe).

Hunting licenses: Nonresident, $100 (permits the killing of 1 moose, 2 deer, 2 caribou, 1 mountain sheep, and 1 mountain goat); licensee in addition may kill 1 moose, 2 deer, 2 caribou, 1 mountain sheep, and 1 mountain goat, but must pay a fee of $25 for each additional animal so taken. Resident, $25 (special license authorizing the killing of male moose and male caribou over 1 year of age at any time for food supplies in the Territory); licensee must make annual returns. Resident: Chief guide, $20; assistant guide, $10. Issued by commissioner or game guardian.

Bag limits and possession: (For limits on big game to a nonresident, see "Hunting licenses.") Six caribou, 6 deer, 2 moose, 2 mountain sheep, 2 mountain goats, 6 bears a season; 25 ducks, 15 geese, 15 brant, 25 in all of rails, coots, and gallinules, and 25 Wilson's snipe a day. Migratory game birds legally taken during open season may be possessed until Apr. 14.

Export: Export of migratory birds prohibited during close season. Upon affidavit of lawful killing, commissioner may issue permit to export game. Export of raw hide of moose or caribou prohibited except under permit. Trophies, including head, hide, and hoofs, of big game lawfully killed by nonresident may be exported under his license and certificate of game guardian.

Sale: Deer, moose, caribou, mountain sheep, and mountain goats lawfully taken may be sold during the open season and 60 days thereafter. Male moose and male caribou more than 1 year of age killed by a resident under special license may be sold at any time for food upon obtaining certificate of lawful killing from a game guardian. License (fee, $10) required to purchase and traffic in flesh of moose or caribou. Licensee must make annual returns. Sale of migratory birds prohibited during close season.

NEWFOUNDLAND

Open seasons:	*Dates inclusive*
Hare, rabbit	Oct. 1–Dec. 20.[64]
Ptarmigan, willow grouse or partridge, goose, plover, curlew, snipe, or "other wild or migratory birds (except crows and hawks, unprotected)"	Oct. 1–Dec. 20.[64]

No open season: Elk, moose, caribou, capercailzie or black game.

Fishing licenses: Nonresident: Fish (salmon and sea trout), season, $26; 14-day license, $10.50; 4 days or less, $2.10 a day. Guide, nonresident, $50; resident free. Issued by game and inland fisheries board.

Unlicensed guides not to be employed. Guide may not conduct party of more than three.

Export: Export or canning of ptarmigan and other game birds prohibited.

Sale: Ptarmigan and willow grouse may be sold Oct. 10–Jan. 1; other birds may be sold during open season; rabbits, Oct. 10–Mar. 15.

---

[61] *Saskatchewan;* Lieutenant governor in council may extend close seasons over current year, within limits, on petition of six game guardians.

[62] Male moose having horns less than 6 inches in length deemed to be under 1 year of age.

[63] *Yukon:* Indians, explorers, surveyors, prospectors, miners, and travelers in need of food may take game during close season. Commissioner in council may alter seasons.

[64] *Newfoundland:* Hare or rabbit may also be taken with trap or snare until Mar. 1. Unlawful to possess hares or rabbits, ptarmigan or grouse in storage, Oct. 1 to Oct. 10.

MEXICO

Open seasons: [65]	*Dates inclusive*
Upland plover	Sept. 1–Sept. 30.
Wilson's snipe or jacksnipe, duck, goose, swan	Nov. 1–Feb. 28.
Other shore birds	Aug. 16–Sept. 30.
White-winged dove	Sept. 16–Nov. 30.
Pigeons and other doves	Oct. 1–Dec. 31.
Wild turkey, curassow, cojolite	Sept. 1–Dec. 31.
Rabbit	Sept. 1–Feb. 28.
Deer, male, north of twentieth parallel	Oct. 16–Jan. 31.
Deer, male, south of twentieth parallel	July 16–Oct. 15.
Bear	Sept. 1–Oct. 31.
Peccary	Aug. 1–Feb. 28.
Alligator	Sept. 16–May 31.
Open seasons—Continued.	*Dates inclusive*
Anteater, kinkajou	Oct. 1–Jan. 31.
Paca, armadillo	Nov. 1–Jan. 31.
Tapir	Sept. 1–Nov. 30.

No open season: Antelope, mountain sheep (1932). Mule deer on Cedros Island (1933). Gulls, insectivorous and song birds, manatees, and the young and females of all animals.

Licenses: [65] Hunting for sport: Nonresident alien: Municipality (10 days), $3.30; 30 days, $8.80. State (30 days), $11; 60 days, $16.50. Country (6 months), $22; 1 year, $44. Resident citizen or resident alien: Municipality (10 days), $1.10; 1 year, $5.50. State (6 months), $5.50; 1 year, $11; country, (6 months), $11; 1 year, $22. Licenses and permits also required for professional and commercial hunting and for the utilization of game products.

Export: Export of live game birds or animals prohibited except under special permit to a limited number of concessionaires. Fees vary for different species.

IMPORTED GAME AND GAME RAISED IN CAPTIVITY

The Department of Agriculture, acting in conjunction with State game officials and sportsmen, aids so far as possible in establishing the game-breeding industry by preparing drafts of suitable laws to be enacted by the States, issuing permits to breeders to obtain wild migratory waterfowl and their eggs, and otherwise advising where stock may be obtained. The department does not distribute breeding stock or eggs, but in proper cases and under suitable restrictions issues permits to assist legitimate enterprises in the conduct of the business of game farming. The possession, sale, and transportation of imported game and game raised in captivity are also regulated in most States by State laws, which are covered in the following summary:

Federal regulations: [66] Under permit from the Secretary of Agriculture, and subject to the provisions of State laws, live migratory waterfowl raised in captivity may be possessed, sold, and transported at any time for propagation and such birds may be killed in any manner (except that they may be killed by shooting only during the open season for waterfowl in the State where killed) and carcasses with heads and feet attached may be sold and transported at any time to any person for actual consumption, or to the keeper of a hotel, restaurant, or boarding house, retail dealer in meat or game, or a club, for sale or service to their patrons who may possess such carcasses for actual consumption without a Federal permit; provided that no migratory waterfowl killed by shooting shall be bought or sold unless each bird before attaining the age of 4 weeks shall have had removed from the web of one foot a portion thereof in the form of a V for identification purposes.

Permits also are issued under proper restrictions and subject to State laws for capturing a reasonable number of wild migratory waterfowl and taking their eggs to enable persons desiring to engage in the business to acquire the nucleus of a breeding stock or to improve the strain of birds on hand but such wild birds may be sold and possessed only for propagation and may not be killed or sold for food.

Alabama: Commissioner of game and fisheries may issue a permit (fee, $1) to capture or export not more than 10 pairs of each species of game or birds for propagating purposes and to sell live game birds or their eggs, raised under permit.

Alaska: Under permit from Secretary of Agriculture wild animals, ducks, geese, and nonmigratory birds may be taken, possessed, bought, sold, and transported for propagation.

Arizona: State game warden may issue permit to take, export, or import game or migratory birds for propagating purposes.

Arkansas: Permit (fee, $2) required to propagate game in captivity.

California: Game raised in captivity under breeder's license (fee, $2.50) may be sold for breeding purposes, and under regulations of commission may be sold for food if tagged (fee, 3 cents a tag). All game raised in captivity (except deer) must be killed otherwise than by shooting. Fish and Game Commission may capture wild game animals and game birds and dispose of them for propagating purposes. Shipments by parcel post are prohibited. Pheasants and domesticated reindeer may be imported and sold under regulations of commission.

Colorado: Game raised in licensed private parks, if accompanied by an invoice, and game (except migratory birds other than migratory waterfowl raised in captivity in conformity with Federal regulation—No. 8) brought into State by licensed importer, if shipping invoice is indorsed to purchaser, may be sold and transported. Commissioner may issue permit to capture or import game for propagating purposes.

Connecticut: Game birds and quadrupeds raised in preserve under license (fee, $2) may be sold and transported, if tagged, under regulations of commissioners of fisheries and game. Game legally taken and transported from another State or country that does not prohibit its sale or export may be sold under regulations of the board. Permit required to import game protected in the State.

Delaware: Pheasants and Hungarian partridges may be possessed and sold for propagating purposes. Board, by permit (fee, $1), may authorize any person to capture, possess, and transport not more than 10 pairs of each species of game or birds for propagating purposes.

District of Columbia: Hungarian partridges English, Mongolian, Chinese, and ring-necked pheasants, and migratory waterfowl raised in captivity, in conformity with Federal regulations, may be possessed, sold, and transported.

Florida: Game-farming license (fee, $5) must be obtained from State game commissioner. Game and birds may be taken for propagation under permit of commissioner and game raised on licensed preserve or farm may be sold for propagation and food purposes.

Georgia: Registered breeder may possess, buy, sell, and transport game for propagation. Game may be taken for propagation, under license (fee, $1).

---

[65] *Mexico:* Secretaria de Agricultura y Fomento, City of Mexico, has authority to establish season and issue licenses.

[66] See Federal regulation 8 for full details and requirements (footnote 1, p. 8).

Idaho: Permit of State game warden required to take or keep waterfowl in captivity for decoy purposes. Under regulations of the State game warden, game may be propagated in private parks.

Illinois: Game raised in captivity under a breeder's license (fee, $5) may be possessed, sold, and transported for propagating purposes and, under special permit, may be killed, transported, and sold for food.

Indiana: Birds and animals raised in captivity may be kept, killed, sold, or transported under certificate of inspection (fee, $5) from the conservation commission, and game birds legally acquired may be possessed for breeding purposes under like certificates. Waterfowl may be taken for propagation under permit.

Iowa: Game birds raised in captivity under license (fee, $2) may be sold for food or propagating purposes.

Kansas: Game raised in captivity under permit (fee, $2) may be sold and transported, and, under permit and regulations of warden, wild animals and birds and eggs of birds may be taken during the open season for propagating purposes.

Kentucky: Game birds and game animals raised in captivity under permit may be sold and transported, but all carcasses must be tagged.

Louisiana: Game raised in captivity under license (fee, $10) may be sold and transported for food, stocking, or breeding purposes, but all carcasses must be tagged. Traffic prohibited in birds killed by shooting. Licensed game breeder may, under permit, take wild animals or birds for breeding stock, but not for killing. Wild birds or mammals may be brought into State for liberation, and game may be exported for educational, scientific, or propagating purposes, under permit from commissioner.

Maine: Wild birds or animals may not be imported, except for captivity purposes, except under permit. Commissioner of inland fisheries and game may issue permit (fee, $5) for propagation of game.

Maryland: Game raised in captivity under breeder's license (fee, $5) may be sold and transported under permit and tag of State warden. Such game must be offered to State warden before being offered for sale elsewhere. Chinese, English, Mongolian, or ring-necked pheasants raised in captivity may be killed by shooting or otherwise during closed season, on premises where raised.

Massachusetts: Licensed dealers may sell unplucked bodies of pheasants, Scotch grouse, European black game, European or gray partridges, red-legged partridges, and Egyptian or migratory quail imported from without the United States, if tagged, and deer, moose, caribou, and elk lawfully killed and coming from without State, if tagged by warden of State or country where procured. Birds and mammals held in possession under permit may be sold at any time for propagation, and tagged carcasses of game raised under permit may be sold for food. Tag fee, 5 cents. Hares and rabbits may be sold during the open season if secured and imported from a country where their sale is not prohibited. Waterfowl may be reared in captivity and sold under Federal regulations (No. 8).[67]

Michigan: Game animals or birds raised in captivity under license (fee $5 to $50) may be sold and transported for food, breeding, or stocking purposes. Carcasses of such game must be tagged (tags, 5 cents each). Director of conservation may issue permit (fee $5) for taking waterfowl or their eggs for propagation. Licensed dealer, club, hotel, restaurant, or boarding house (fee, $5) may sell or serve imported game or game raised in capitivity, if tagged, to patron or customer for actual consumption or use

Minnesota: Game (except deer and Hungarian partridges) raised in capitivity under license (fee, $3, and 15 cents additional for each acre over 10 acres) may be sold alive for propagating purposes and may be killed, sold, and transported under regulations of commissioner. Under regulations of the commissioner, wild animals and birds and eggs of birds may be taken for propagation.

Mississippi: Licensed owner or operator of game preserve may buy, sell, or transport within or out of the State for propagating purposes game raised on such preserve, but no game may be shipped out of State except during open season thereon.

Missouri: Deer, elk, and other protected game raised in captivity under license (fee, $5) may be transported and sold under regulations of commissioner. Export (except of quail) for propagating purposes allowed under permit. Commissioner may issue permit (fee, $5) for taking game for propagation.

Montana: Game raised in private preserves under license (fee, $5) may be killed, sold, and transported. Commission may authorize capture under permit of wild animals and birds for propagation.

Nebraska: Game animals and birds may be raised in captivity for profit under license (fee, $5), may be sold for propagation, and killed and sold for food purposes if tagged. Game raised under permit for sale must be offered first to the State, and if not taken by State it may then be exported, or may be slaughtered and sold, if tagged. Game legally possessed in another State may be imported under permit. Keeper of hotel, boarding house, restaurant, club, or retail dealer in meats under license (fee, $5) may sell tagged game to patron or customer for actual consumption, but tags must remain on carcasses until consumed.

Nevada: Game raised under license (fee, $25) may be sold or shipped under invoice. Fish and game commissioners may issue permit to take game for propagation.

New Hampshire: Game raised in captivity under license (fee, $2) may be sold and transported, if tagged, under regulations of commissioner. Game (except ruffed grouse) imported from without the United States or raised in private preserves, if tagged and marked to show kind and number, name and address of consignor and consignee, initial point of billing, and destination, may be exported unaccompanied by owner.

New Jersey: Mallard, wood, and black ducks, Canada geese,[67] English and Mongolian pheasants, quail, ruffed grouse, deer, rabbits, raccoons, and squirrels raised in inclosed preserves under license (fee, $5) may be possessed and sold for propagation, and may be sold for food or exported for sale if tagged (tag fee, 5 cents). Unplucked carcasses of Scotch grouse, European black grouse, European black plover, red-legged partridges, and Egyptian quail coming from a foreign country, if tagged by State authorities, may be sold for food purposes. Licensee before shipping live propagated game from State must tender same to commission. Additional $5 fee required for shipping live deer from State.

New Mexico: Game may be raised in licensed preserve. State warden may issue permit (fee, $1.25) to retain in captivity not more than 4 abandoned young of big game that applicant has rescued. Holder of a hunting license, under permit from State warden, may capture and export game or birds for propagating purposes. Game (except migratory birds other than waterfowl raised in captivity in conformity with Federal regulations[67]) coming from without State may be possessed and sold by a hotel, restaurant, café, boarding house, or dealer under a permit good for not more than 30 days. Permit required for importation of live animals and birds except domesticated animals and fowls.

New York: Conservation department may issue license (fee, $1, bond, $200) permitting the taking of birds and animals for propagation, and may also issue license (fee, $1) for possession, sale, and transportation of birds and animals for propagation.

Elk, mule deer, white-tailed deer, European red deer, fallow deer, Japanese deer, roebuck, pheasants, bobwhite, quail, Hungarian or gray-legged partridges, Canada and Hutchins's geese, and mallard and black ducks raised in captivity under license (fee, $5) may be sold for breeding purposes; carcasses of quail or Hungarian or gray-legged partridges raised in State, may not be sold for food nor may those killed by shooting be bought, sold, or trafficked in, but all other species mentioned may be killed, shipped, and sold or exported for food, if tagged. Such ducks and geese may be killed by shooting during the open season, but when so killed may not be sold unless marked and tagged as required by conservation department.[69] Varying hares and cotton-tail rabbits raised in captivity under license (fee, $5) if tagged, may be sold for food purposes during close season, under regulations of department.

---

[67] See Federal regulation 8 for full details and requirements (footnote 1, p. 8).

Licensed breeders in States having laws similar to the game breeding law of New York may, under license (fee, $5 and cost of inspection), ship into State domesticated American elk, white-tailed deer, European red deer, fallow deer, roebuck, pheasants, Canada and Hutchins's geese, and mallard and black ducks, which, if tagged, may be sold under regulations of department.

License to possess and sell birds and quadrupeds for propagation, scientific, educational, or exhibition purposes, fee, $1.

Unplucked carcasses of tinamou, pheasants, Scotch grouse, European gray-legged partridges, Norwegian ptarmigan, Norwegian grouse, and Egyptian quail, and species or subspecies not native to State, and carcasses of European red deer, fallow deer, and roebuck imported from without the United States may be sold under license if tagged. No restrictions on reindeer.

North Carolina: Game may be raised in domestication under permit (fee, $2) and regulations of department of conservation and development, and may be taken for propagation. Hotels, cafés, clubs, etc. may sell and serve propagated game under permit (fee, $10).

North Dakota: Game may be kept in captivity under permit of commissioner.

Ohio: Ring-necked, Mongolian, or Chinese pheasants and mallard and black ducks raised in captivity under a breeder's license (fee, $5) may be sold and transported for food or propagating purposes; carcasses of such birds must be tagged. No pheasant, mallard, or black duck raised in captivity may be killed by shooting except during the open season, and no mallard or black duck killed by shooting may be bought or sold unless it shall have had a well-defined V-shaped section removed from the web of one foot before attaining the age of four weeks.

Deer, squirrels, and rabbits legally taken or acquired may be possessed in inclosures as pets.

Oklahoma: Game raised under license (fee, $2) may be sold and transported for propagation and for food, if tagged, during season prescribed by commission. Wild animals or birds may not be taken in State for breeding purposes but State game warden may furnish game birds for propagation to resident landowner.

Oregon: Game birds and animals raised in captivity under permit (fee, $2) may be exported or sold for propagating, restocking, or food purposes; carcasses must be tagged (fee, 5 cents). Written permit from State warden, showing kind of game and names and addresses of consignor and consignee, must be attached to each shipment.

Game animals and birds coming from without the United States and game taken in a State where it may be sold, may be sold and transported under permit and tag of State warden, but the only migratory birds that may be sold are waterfowl reared in captivity under Federal[69] or Canadian regulations.

Pennsylvania: Game breeder's certificate required, fee, $1; bond, $500. Game raised in captivity may be sold or transported within State; or, under permit, out of State but before live game raised under permit is shipped out of State it must be offered for sale to commission. Live game may be imported under permit.

Rhode Island: Game raised in captivity under permit may be sold for propagation, under regulations of commissioners. Live game animals and birds, and game lawfully killed and exported may be brought into State under permit, but such game may not be sold.

South Carolina: Game birds may be raised in captivity, and sold and shipped, under license (fee, $2.50).

---

[69] See Federal regulation 8 for full details and requirements (footnote 1, p. 8).

South Dakota: Game raised in captivity under license may be exported or sold under written permission of State game warden.

Tennessee: Under permit (fee, $1) of State warden 10 pairs of game animals or birds may be taken for propagation. Special law in Rutherford County.

Texas: Game animals and birds may be captured or imported for propagating purposes under permit of commissioner.

Utah: Game raised in private preserve under permit (no fee) of commissioner may be sold and transported, if tagged. Game may be taken for propagation under permit and direction of commissioner.

Vermont: Game raised in licensed private preserve (fee, $2) may be sold or exported for food or propagating purposes. Carcasses must be tagged.

Virginia: Game animals and birds raised under breeder's license (fee, $25) may be disposed of for propagating or restocking, and, under regulations of commission, for other purposes.

Game breeder's license issued only to residents of State. Breeding stock may be acquired as determined by commission.

Washington: Game animals and birds raised in captivity under license (fee, $20; renewal, $10 annually) may be sold and transported at any time, or sold for food, if tagged. Keeper of hotel restaurant, boarding house, or club, and retail dealer in meats may sell game raised under game farmers license, if tagged. Under permit from supervisor of game and game fish, wild animals and birds may be imported from without State for propagating purposes.

Game animals and birds coming from without State, if reported, within three days and tagged (fee, 25 cents a tag), may be possessed for tanning, mounting, manufacturing, or ornamental purposes and disposed of in usual course of trade, but the only migratory birds that may be sold are waterfowl reared in domestication under Federal and Canadian regulations.[69]

West Virginia: The owner may kill elk or deer kept in inclosure. Game and fur animals, game birds, fish, and frogs may be taken under permit (fee, $1) for propagation, but they may not be sold or bartered.

Wisconsin: Owner or lessee of lands within State may obtain license (fee, $5; renewal, $2) from conservation commission, and after inclosing property as required by law becomes owner of all game thereon and its increase. Such birds may be sold alive for propagation, or may be killed and sold for food when tagged (tag, fee 5 cents each), but no migratory waterfowl may be killed and sold except those actually bred in captivity under Federal permit.[69] Commission may issue permits to park boards to take, possess, sell, and ship wild animals for park purposes, and to individuals to take for propagation under supervision of commission.

Wyoming: Under permit (fee, $10) and supervision of commission, game animals may be taken for propagation. Animals so taken may not be killed, sold, or disposed of for three years, but their natural increase may be sold, transported, and disposed of. Exchange of game animals and birds for liberation in State allowed under permit of State game commission.

Canadian regulations:[70] The Canadian regulations, administered by the commissioner of national parks of Canada, Ottawa, are similar to the provisions of the Federal regulations in respect to propagation of migratory waterfowl, but apply to all migratory birds protected by the treaty; and all birds raised in captivity and intended for food purposes must be killed otherwise than by shooting, and each of such birds before it can be sold must bear a metal tag, which may not be removed from carcass. Under section 5 of the Canadian customs export act (R. S. C., 1906, ch. 50) a person may export carcass or parts thereof of a deer raised on his own land or on lands owned by a company or association of which he is a member, upon his making affidavit on face of export entry that the carcass, or part thereof, is of a deer so raised.

---

[69] See Federal regulation 8 for full details and requirements (footnote 1, p. 8).

[70] See Canadian regulation 13 (footnote 1, p. 8).

Alberta: Minister of agriculture may authorize persons to possess, buy, sell, and export big game and game birds raised in captivity, and to capture big game and game birds for propagation. Permit fees fixed by lieutenant governor in council.

British Columbia: Game commissioner may authorize persons to possess, buy, sell, and export game animals and game birds raised in captivity, and to capture game animals and birds and collect eggs of birds for propagation. Permit required to import live animals or birds into the Province; permit fees fixed by lieutenant governor in council.

New Brunswick: Minister of lands and mines may authorize persons to possess, buy, sell, and export game raised in captivity, and to capture game for propagation. Permit fees fixed by minister.

Northwest Territories: Minister of the interior may authorize persons to possess, buy, sell, and export wild mammals and birds raised in captivity, and to capture wild mammals and birds and collect eggs of birds for propagation.

Nova Scotia: Minister may authorize persons to possess, buy, sell, and export wild mammals and birds raised in captivity, and to capture wild mammals and birds for propagation.

Ontario: Minister of game and fisheries may authorize persons to possess, buy, sell, and export game animals and birds raised in captivity, and to capture game animals and birds for propagation during close season. Imported game may be sold or exported under license.

Prince Edward Island: Domesticated wild geese and brant in captivity are deemed personal property of owner, and may be possessed, disposed of, and transported without reference to the provisions of the provincial game act. Waterfowl and other migratory birds, however, are subject to the provisions of the migratory birds convention act and regulations.[70]

Quebec: Minister may authorize game animals and birds lawfully taken during the open season to be retained in captivity.

Saskatchewan: Minister or railways, labor, and industries may issue permit (fee, $5) for propagation of game for commercial purposes, and to capture big game and game birds for propagation. All shipments must be tagged, permit and tag fees fixed by minister.

Yukon: Gold commissioner may authorize persons to possess, buy, sell, and export game animals (except buffalo or bison) and birds raised in captivity, and to capture such animals and birds for propagation.

Newfoundland: Game and inland fisheries board may authorize persons to capture, possess, buy, sell, and export caribou for propagation. Eggs of wild geese may be taken until May 15 for propagation only.

---

[70] See Canadian regulation 13 (footnote 1, p. 8).

FIELD SERVICE, DIVISION OF GAME AND BIRD CONSERVATION, BUREAU OF BIOLOGICAL SURVEY

[Violations of Federal game laws may be reported to the nearest official listed, or to the Chief, Bureau of Biological Survey, United States Department of Agriculture, Washington, D. C.]

UNITED STATES GAME PROTECTORS

Harry Barmeier	4947 Schollmeyer Avenue, St. Louis, Mo.
William L. Birsch	P. O. Box 177, New Bern, N. C.
Louis A. Branchaud	Biological Survey, Washington, D. C.
B. R. Britton	Box 185, Socorro, N. Mex.
M. A. Charlton	2106 Summit Street, Columbus, Ohio.
Frank Clarkson	Box 1168, Houston, Tex.
Stephen Creech	Box 306, Peoria, Ill.
P. S. Farnham	Owego, N. Y.
————	Box 1022, Mobile, Ala.
John Q. Holmes	1514 Howard Street, Omaha, Nebr.
Floyd A. Johnson	1301 General Taylor Street, New Orleans, La.
Jay V. Kelsey	P. O. Box 1825, Daytona Beach, Fla.
Chester A. Leichhardt	516 Post Office Building, Portland, Oreg.
S. W. Linebaugh	Russellville, Ky.
Lawrence J. Merovka	318 Federal Building, Memphis, Tenn.
John E. Perry	Sherman Hotel, Kansas City, Mo.
W. H. Ransom	Box 94, Spokane, Wash.
George M. Riddick	Box 815, Little Rock, Ark.
Kenneth F. Roahen	Box 438, Billings, Mont.
B. J. Shaver	General Delivery, St. Paul, Minn.
Bertrand E. Smith	21 Rosemont Avenue, Portland, Me.
Albert Stadlmeir	45 Loraine Avenue, Pleasantville, N. J.
Orin D. Steele	125 Willis Street, Cambridge, Md.
George Tonkin	Box 399, Berkeley, Calif.
E. B. Whitehead	532 East Fiftieth Street, Savannah, Ga.

SUPERINTENDENTS OF FEDERAL WILD-LIFE REFUGES

Ray C. Steele	Upper Mississippi River Wild Life and Fish Refuge, Winona, Minn.
George E. Mushbach	Bear River Migratory-Bird Refuge, Bigelow Hotel, Ogden, Utah.

UNITED STATES RESERVATION PROTECTORS

George M. Benson	Lake Malheur Bird Reservation, Voltage, Oreg.
Steven B. Crossley	Big Lake Bird Reservation, Manila, Ark.
Geno A. Amundson	Niobrara Reservation, Valentine, Nebr.
H. Harrison Hoyt	Wind Cave Game Preserve, Hot Springs, S. Dak.
Almer P. Nelson	Elk Refuge, Jackson, Wyo.
Wesley D. Parker	Sullys Hill Game Preserve, Fort Totten, N. Dak.
Robert S. Norton	National Bison Range, Moiese, Mont.

U. S. GOVERNMENT PRINTING OFFICE: 1931

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - - - - Price 5 cents

U. S. DEPARTMENT OF
AGRICULTURE
FARMERS' BULLETIN No. 1685

FUR LAWS
FOR THE SEASON
1931-32

THE PURPOSE of this publication, the seventeenth annual summary of the fur laws by the Department of Agriculture, is to acquaint trappers, fur dealers, administrative officials, and others with the provisions of Federal and State laws relating to fur animals, and to stimulate action on the part of all concerned in maintaining adequate breeding stocks of the fur bearers. While it is primarily the province of the individual States to enact and enforce laws for the protection of fur animals, the Department of Agriculture, under the provisions of the act of May 25, 1900, known as the Lacey Act, has jurisdiction over the interstate shipment of the dead bodies or parts thereof of wild animals that have been killed or shipped in violation of State law. In administering this act it is the policy of the department to cooperate to the fullest extent with State game officials, organizations, and individuals with a view to advancing the common interests of the public and aiding in the conservation of the species.

The illustration on the title page is of mink (*Mustela vison*) from a drawing by L. L. Pray.

Washington, D. C. Issued November, 1931

OFFICIALS FROM WHOM COPIES OF FUR LAWS MAY BE OBTAINED AND TO WHOM VIOLATIONS MAY BE REPORTED

Federal laws: Secretary of Agriculture, Washington, D. C.
Alabama: Department of Game and Fisheries, Montgomery.
Alaska: Executive Officer, Alaska Game Commission, Juneau; or Secretary of Agriculture, Washington, D. C.
Arizona: State Game Warden, Phoenix.
Arkansas: Secretary, Game and Fish Commission, Little Rock.
California: Executive Officer, Fish and Game Commission, Russ Building, San Francisco.
Colorado: State Game and Fish Commissioner, Denver.
Connecticut: Superintendent of Fisheries and Game, Hartford.
Delaware: Chief Game and Fish Warden, Dover.
District of Columbia: Superintendent, Metropolitan Police, Washington.
Florida: State Game Commissioner, Tallahassee.
Georgia: Game and Fish Commissioner, Atlanta.
Hawaii: Fish and Game Division, Board of Agriculture and Forestry, Honolulu.
Idaho: Fish and Game Warden, Boise.
Illinois: Director, Department of Conservation, Springfield.
Indiana: Superintendent of Fisheries and Game, State House, Indianapolis.
Iowa: State Fish and Game Warden, Des Moines.
Kansas: State Fish and Game Warden, Pratt.
Kentucky: Executive Agent, Game and Fish Commission, Frankfort.
Louisiana: Commissioner of Conservation, Court Building, New Orleans.
Maine: Commissioner of Inland Fisheries and Game, State House, Augusta.
Maryland: State Game Warden, 512 Munsey Building, Baltimore.
Massachusetts: Director, Division of Fisheries and Game, 20 Somerset Street, Boston.
Michigan: Director, Department of Conservation, Lansing.
Minnesota: Game and Fish Commissioner, Department of Conservation, St. Paul.
Mississippi: Secretary of State, Jackson, or Sheriff or County Clerk.
Missouri: Game and Fish Commissioner, Jefferson City.
Montana: State Fish and Game Warden, Helena.
Nebraska: State Game Warden, Lincoln.
Nevada: Secretary, State Fish and Game Commission, Reno.
New Hampshire: Fish and Game Commissioner, Concord.
New Jersey: Secretary, Board of Fish and Game Commissioners, Trenton.
New Mexico: State Game Warden, Santa Fe.
New York: Chief, Division of Fish and Game, Department of Conservation, State Office Building, Albany.
North Carolina: State Game Warden, Department of Conservation and Development, Raleigh.
North Dakota: Game and Fish Commissioner, Bismarck.
Ohio: Conservation Commissioner, Columbus.
Oklahoma: State Fish and Game Warden, Oklahoma City.
Oregon: State Game Commission, 616 Oregon Building, Portland.
Pennsylvania: Executive Secretary, Board of Game Commissioners, Harrisburg.
Rhode Island: Chairman, Commissioners of Birds, Providence.
South Carolina: Chief Game Warden, Columbia.
South Dakota: Director, Game and Fish Commission, Pierre.
Tennessee: State Game and Fish Warden, Department of Agriculture, Nashville.
Texas: Game, Fish, and Oyster Commission, Austin.
Utah: Fish and Game Commissioner, Salt Lake City.
Vermont: Fish and Game Commissioner, Montpelier.
Virginia: Executive Secretary, Department of Game and Inland Fisheries, Richmond.
Washington: Supervisor of Game and Game Fish, 404 Bell Street Terminal (P. O. Box 384), Seattle.
West Virginia: Game, Fish, and Forestry Commission, Charleston.
Wisconsin: Conservation Director, Madison.
Wyoming: State Game and Fish Commission, Cheyenne.

Alberta: Game Commissioner, Edmonton.
British Columbia: Game Commissioner, 411 Dunsmuir Street, Vancouver.
Manitoba: Director of Game and Fisheries, Winnipeg.
New Brunswick: Chief Game Warden, Fredericton.
Northwest Territories: Director, Northwest Territories and Yukon Branch, Department of Interior, Ottawa, Ontario.
Nova Scotia: Minister of Lands and Forests, Halifax.
Ontario: Department of Game and Fisheries, Toronto.
Prince Edward Island: Game Inspector, Provincial Treasury Department, Charlottetown.
Quebec: General Superintendent of Fisheries and Game, Quebec.
Saskatchewan: Game Commissioner, Regina.
Yukon: Territorial Secretary, Dawson.

Newfoundland: Secretary, Game and Inland Fisheries Board, St. Johns.
Mexico: Secretaria de Agricultura y Fomento, San Jacinto, D. F.

FUR LAWS FOR THE SEASON 1931–32

By H. P. Sheldon, *United States Game Conservation Officer, in Charge*, and Frank G. Grimes, *Junior Administrative Assistant, Division of Game and Bird Conservation, Bureau of Biological Survey*

CONTENTS

	Page
Steadily declining fur catch	1
Review of legislation of 1931	2
Federal regulations for Alaska	2
State laws	2
Summary of laws	5
Federal laws	5
Laws of States	6
Summary of laws—Continued.	
Laws of Canada	25
Laws of Newfoundland	29
Laws of Mexico	29
United States game protectors of the Bureau of Biological Survey	30

STEADILY DECLINING FUR CATCH[1]

THE PRICES PAID for raw furs are largely influenced by financial conditions in other industries, and in times of depression this commodity is one of the first to register a decline and generally one of the last to recuperate. There is, however, no overproduction of raw furs and no large supply in storage. During the winter season of 1930–31 fewer peltries were taken in the United States than in the previous year. In fact, for the last five years there has been a steady decline not only in the catch but also in the number of skins reaching raw-fur receiving houses. This year, as never before, all concerned in the various phases of the fur industry have realized that the number of skins taken annually is steadily on the decline.

Of all the causes of smaller offerings of peltries on the fur market, the chief, of course, is overtrapping over many years in the face of reduced breeding areas. Other conditions detrimental to the fur bearers and to the trapping industry have naturally played their part, some with almost equally disastrous results. The floods of 1927 destroyed numbers of fur animals in the Mississippi Basin and the New England States. The extensive and severe drought of 1930 had a detrimental effect on all fur animals, but especially on those living in or about the water. Because of lower prices quoted for raw skins during the seasons 1929–30 and 1930–31, many trappers discontinued operations.

In the case of martens and fishers still another condition is responsible for rapid depletion. Investigations conducted by the Bureau of Biological Survey have demonstrated that martens normally breed in July and August and that the young are not born until eight and one-half to nine and one-half months later; and the indications are that the gestation period in fishers is even longer than in martens. These findings reveal the fact that the laws permit the trapping of both martens and fishers over many parts of their ranges when the females are carrying young, a condition along with others that threatens at least local extinction to these valuable species.

---

[1] Introductory section contributed by Frank G. Ashbrook, principal biologist, in charge division of fur resources.

Federal and State conservation officials, fur tradesmen, and fur farmers generally recognize the fact that the wild-life resources are to be protected for the use of the people of the States, as well as for purely conservational ends. All should work out their problems together and present a united front in urging legislation for the conservation of fur animals. Cooperation in such conservation will become general only when all concerned with the utilization of the fur resources realize the importance of research preliminary to legislation on subjects vital to the fur industry.

It must continually be emphasized that conditions detrimental to the fur supply are made even more unfavorable when trappers ply their trade out of season, thereby not only lessening the annual catch but reducing some species below the point where commercial trapping is possible and profitable.

REVIEW OF LEGISLATION OF 1931

FEDERAL REGULATIONS FOR ALASKA

By amendment to regulations under the Alaska game law, the number of fur districts for the Territory is increased from three to eight. The boundaries are described in detail in the footnote under Alaska on page 6. Other changes effected by the amendment are a reduction from $250 to $100 in the fee charged nonresident fur dealers, fur corporations or copartnerships not organized under the laws of the Territory, and agents of nonresident buyers. The new regulations provide a sealing system for the skins of beavers and martens, whereby such skins must be presented to the Alaska Game Commission or an authorized agent for sealing within 90 days after the close of the season where taken, except in fur district 1, where they must be presented within 30 days. In all cases affidavits showing lawful taking must be presented in prescribed form. The possession and sale of unsealed beaver and marten skins is made unlawful after the allotted period.

Beaver.—The season on beaver was opened in parts of districts 1, 2, and 7, and throughout districts 4, 5, and 6. The season remains closed in districts 3 and 8; on Chichagof and Baranof Islands, in district 1; on the Kenai Peninsula south of Portage Creek eastward to the head of Portage Canal, in district 2; and in the drainage to Chandalar River, in district 7. A bag limit of 10 a season was prescribed in districts 1 and 7, and 15 a season in districts 2, 4, 5, and 6.

Marten.—Open seasons from December 16 to January 15 and from November 6 to February 20, respectively, were prescribed on marten in districts 1 and 7, the season remaining closed elsewhere in the Territory. A bag limit of 10 a season was provided for the open districts.

Other land fur animals.—Varying seasons were prescribed throughout the Territory on muskrat; mink; land otter; weasel (ermine); red, cross, silver, white, and blue foxes; and lynx. The details are set forth in Circular No. 8 of the Alaska Game Commission.

STATE LAWS

Regular sessions of the legislatures have been held in 44 of the States since last years farmers' bulletin on the fur laws (No. 1648) was published. In many of these States changes in the trapping laws were made by legislative enactment, and in others by commission order or regulation. The general trend of legislation or commission action was toward a liberalization of the trapping laws and regulations, and, in some States there was a noticeable reduction in the fees charged for licenses.

SEASONS

Bear.—Protection was afforded bears in Arizona south of the Gila River, and in Georgia the season was shortened, closing February 1 instead of February 28. Arkansas provided a split season of November 9 to 14 and December 20 to January 1.

Raccoon.—In Georgia the season on raccoon was shortened, to close February 1 instead of February 28. In parts of the Lower Peninsula of Michigan the season was extended 15 days, opening November 1 instead of November 16. Minnesota changed the season from the period October 20 to November 20 to the period November 1 to December 1. In North Dakota the season was shortened 69 days, opening November 15 instead of November 1 and closing February 15 instead of March 31. The general season was shortened 14 days in Pennsylvania, opening October 15 instead of November 1 and closing December 15 instead of January 15, while in 18 counties a 62-day season, from November 1 to January 1 was prescribed. In South Dakota, where raccoons were previously unprotected, an open season of three months, from November 1 to January 31 was provided, thus affording them protection throughout nine months of the year.

Marten and fisher.—Michigan continued indefinitely the closed season on marten and fisher, and the season was closed this year on these species in Washington.

Mink.—Georgia shortened the season on mink, closing February 1 instead of February 28. In North Dakota the season was shortened 69 days, from the period November 1 to March 31 to the period November 15 to February 15. The season was opened in Oklahoma December 1 to January 31.

Otter.—Kansas and Michigan retained the closed season on otters, while protection was removed from them in North Dakota and in 40 counties in Texas. Washington closed the season entirely, and protection was removed in one county in Wisconsin.

Skunk.—North Carolina removed protection from skunks, and North Dakota and Rhode Island shortened the season one month, opening November 1 instead of October 1 in the former and closing March 15 instead of April 15 in the latter. In South Dakota the season was shortened 76 days, and Wisconsin removed protection in one county.

Fox.—Kansas prescribed a season from November 16 to January 31 on foxes. North Carolina closed the season except in five counties, where it remains open throughout the year. North Dakota shortened the season 69 days as in the case of mink and raccoon. In Oklahoma foxes were declared game animals, and it was made unlawful wantonly to kill them. The pelts of foxes legally killed, or accidentally killed while being chased for sport, must be delivered to the clerk of the school district in which killed, and proceeds from sale of such pelt applied to the general fund of the district. Tennessee removed protection from foxes in 2 counties, and Vermont in 1 county, while the season was closed in 43 counties in Texas.

Beaver.—Seasons were opened on beaver in five States, Arkansas providing a split season of November 9 to 14 and December 20 to January 1. Kansas prescribed a season from November 16 to January 31, while in Michigan a 16-day season from December 5 to 20 was provided in 19 counties; previously the season was closed throughout the State. In Oregon protection was removed in four counties and part of another. Texas opened the season for one month west of the Pecos River and removed protection entirely in 40 counties east of the Pecos. In Georgia the season was shortened one month, closing February 1 instead of February 28.

Muskrat.—In Maine the season on muskrat was shortened 46 days in the 8 southern counties, and 16 days in the remainder of the State. The season in Nevada was extended 63 days to the period November 15 to March 15, conforming to the season on other fur animals. South Dakota shortened the season 17 days, opening January 15 instead of December 15 and closing March 15 instead of March 1. In Texas the season was extended 17 days in 1 county, while in Wisconsin the season was opened October 25 to April 1 in 2 additional counties, thus making that season apply in 7 counties.

Other fur animals.—In Kansas an open season of November 16 to January 31 was prescribed for civet and badger, while separate seasons were prescribed for badgers in Michigan north and south of township 16. The season on badgers was shortened 31 days and on weasel 69 days in North Dakota. Ring-tailed cats in Oregon were grouped in the season with other fur animals.

Miscellaneous.—Tennessee repealed a number of local laws relative to trapping, enacted local laws in 5 counties, and closed 2 counties to all trapping. In Texas one additional county was closed to all trapping.

LICENSES AND FEES

Residents.—Arizona abolished the fee charged residents for trapping licenses, but required that they procure the license. In Arkansas a resident using more than 12 traps must procure a $20 license; a resident over 18 years of age may use 12 or less traps under a resident hunting license, the fee for which is $1.10, while a resident under 18 years of age may use 12 or less traps without a license. Michigan increased the trapping license fee from $1.25 to $1.75, and the special muskrat trapping license from $1 to $2. In New York the license fee was increased from $1.25 to $2.25; Oregon increased the fee from $2 to $3, and South Dakota reduced the fee from $5 to $2. Tennessee prescribed that a resident hunting license must be procured to trap fur animals except in one county. West Virginia adopted a $3 state-wide trapping license, and a $1 license for county of residence and adjoining counties.

Nonresidents.—In Arkansas a nonresident trapping license, costing $50, was adopted, in lieu of the former $20 hunting license.

Fur buyers.—*Resident:* Illinois and Indiana prescribed a $10 license fee for resident fur buyers. In Iowa the fur-buyer or fur-dealer license was reduced from $25 to $10, and the bond required of the licensee was reduced from $2,000 to $500. Oregon prescribed a $10 license fee for fur dealers, with a $3 license for dealer's agent. Tennessee, Vermont, and Washington adopted licenses of $20, $2, and $10 respectively. *Nonresident:* In Illinois, Indiana, New Jersey, and Vermont nonresident buyers are assessed $50. North Dakota reduced the fee from $50 to $25.

Fur farmers or breeders.—Idaho adopted a fur-farm permit or license, prescribing fixed fees for each species to be raised. Applicant is required to deposit $100 to cover expenses incident to inspection and examination of premises, any balance remaining being returned to him. Upon issuance of permit, the permittee becomes the owner of any fur animals then on the premises.

In Maine the fee for fur breeder's permit was reduced from $20 to $10. New York reduced from $10 to $1 the cost of license to breed and possess ferrets. Oregon adopted a provision requiring the tagging of the skins of all animals raised in captivity.

BAG LIMITS

Arizona prescribed a seasonal limit of 1 bear and 2 beavers; New Hampshire a seasonal limit of 20 raccoons; and Pennsylvania fixed the limit on raccoon at 3 a day, 10 a season.

BOUNTIES

Kansas rescinded the bounty on wolves, increased it on coyotes from $1 to $2, and authorized county commissioners to pay 10 cents each on jack rabbits. In Maine the bounty on bobcats and Canada lynxes was increased from $10 to $20. Wisconsin increased from $1 to $10 the bounty on wolf cubs taken between March 1 and November 1. Maryland discontinued the bounty on hawks, and Missouri placed a bounty of 50 cents on eagles.

SUMMARY OF LAWS

In stating the open seasons in the following summary, the plan is followed, as in the bulletin on the game laws,[2] of including the first and last days thereof. Statements regarding trapping on lands of another do not take into consideration the general trespass laws. The statements relative to bounty laws include, for convenience, all mammals and birds on which bounties are paid.

FEDERAL LAWS

Two Federal laws have a bearing on the fur industry of the United States—the Lacey Act, governing interstate commerce in wild animals, and the tariff act of June 17, 1930.

The Lacey Act (U. S. Code, title 18, sec. 392) provides that it shall be unlawful to deliver to a common carrier for transportation, or for any common carrier to transport, from any State, Territory, or District of the United States, to any other State, Territory, or District thereof, the bodies or parts thereof of any wild animals killed or shipped in violation of the law of the State, Territory, or District in which killed or from which shipped.

The tariff act of June 17, 1930, places a duty of 15 per cent ad valorem on all live wild animals shipped into the United States, including silver and black foxes and rabbits. (Par. 715.) The skins of foxes, dressed or undressed, and manufactures thereof, are dutiable at 50 per cent ad valorem. Other raw furs and skins are admitted free of duty. Furs dressed on the skin (except silver and black foxes) and not further advanced than dyeing are dutiable at 25 per cent ad valorem. Manufactures of fur (except silver or black fox) further advanced than dressing, prepared for use as material, if not dyed, are dutiable at 35 per cent ad valorem, and if dyed, at 40 per cent ad valorem. (Par. 1519.) All animals imported for breeding purposes, other than silver and black foxes, are admitted free of duty when of pure breeds and registered in a book of record recognized by the Secretary of Agriculture. Since such recognition has not been given foxes, rabbits, and other fur bearers, importers of these animals do not benefit by the duty-free provisions of the tariff act. (Par. 1606.)

---

[2] Laws relating to game animals and birds may be found in Farmers' Bulletin No. 1684, Game Laws for the Season 1931-32.

LAWS OF STATES

ALABAMA

Open seasons: [3]	*Dates inclusive*
Beaver, otter, bear, raccoon, fox, opossum, mink, muskrat (trapping)	Nov. 1–Feb. 29

Prohibited methods: Unlawful to set traps in a manner dangerous to domestic stock. Use of steel traps prohibited in Choctaw, Coffee, Crenshaw, Dallas, and Perry Counties.

Licenses: Fee, $15 for first trap and $2.50 for each additional trap; issued by probate judges. Landowners or landlords, and members of families may trap on own land during open season without license. Written permission required to trap on land of another.

Possession and sale: Possession of young of protected fur animals prohibited during close season. No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: Under special permit from commissioner of game and fisheries, fur animals may be captured or possessed for propagation.

Bounties: None paid.

ALASKA [4]

Open seasons: [5]	
Beaver:	*Dates inclusive*
In fur district 1 (see exception)	Dec. 16–Jan. 15.
Exception: On Chichagof and Baranof Islands	No open season.
In district 2 (see exception)	Jan. 1–Feb. 29.
Exception: On Kenai Peninsular south of north bank of Portage Creek eastward to head of Portage Canal	No open season.
In districts 3 and 8	No open season.
In districts 4, 5, 6, and 7 (see exception)	Jan. 1–Mar. 31.
Exception: In drainage area to Chandalar River in district 7	No open season.

---

[3] *Alabama:* Owner may protect premises in any manner at any time from depredations of fur animals. Fur animals may be hunted with dog or gun: Sept. 1–Feb. 29.

[4] *Alaska:* Regulations under Alaska game law of Jan. 13, 1925, relating to land fur animals may be obtained upon application to Department of Agriculture, Washington, D. C., or to Alaska Game Commission, Juneau, Alaska. For special information regarding sea otters and fur-seal fisheries and Afognak Reservation, which are subject to special legislative and administrative control, application should be made to Commissioner of Fisheries, Washington, D. C. For law and regulations governing leasing of public lands in Alaska for fur-farming purposes, application should be made to Commissioner, General Land Office, Washington, D. C. Following are the fur districts specified by the regulations:

Fur district 1.—All of southeastern Alaska from Dixon Entrance to Cape Fairweather and along longitude 138° to the international boundary.

Fur district 2.—That portion of southern Alaska draining to the Gulf of Alaska and Cook Inlet, beginning at western boundary of Fur District 1 and following longitude 138° from Cape Fairweather to the international boundary and along this boundary to Mount St. Elias; thence following summit of Chugach Range to Miles Glacier; thence down the center line of said glacier to the center of the Copper River & Northwestern Railway bridge across the Copper River at mile 49; thence up the center line of Childs Glacier to its summit; thence along the divide through Marshall Pass and Thompson Pass to Tahneta Pass; thence along the divide separating the waters of the Matanuska River from the Nelchina River and the Talkeetna River from the Oshetna River; thence along the divide separating the waters of the Oshetna River from Kosina Creek to and across the Susitna River at a point 4 miles northwest of the mouth of Goose Creek; thence along the divide separating the waters flowing northwest into the Susitna River from those flowing southerly into the Susitna River; thence following said divide separating the waters flowing north into the Nenana River from those flowing southerly into the Susitna and Chulitna Rivers and across Broad Pass and the Alaska Railroad at mile 308; thence along the divide separating the waters flowing south into the Chulitna River from those flowing north into Cantwell Creek and the Nenana River to the summit of the Alaska Range; thence along said summit through Rainy Pass to Merrill Pass; thence along the summit of the Chigmit Mountains, separating the waters flowing easterly into Cook inlet from those flowing westerly into the Kuskokwim River and Bristol Bay, to its intersection with the old portage from Kamishak Bay to Kakhonak Bay on Iliamna Lake; thence along said portage to Kamishak Bay.

Fur district 3.—Consisting of the Aleutian Islands, Unimak Island, Amak Island, all the islands lying south of the Alaska Peninsula, the Kodiak Afognak Islands group, the Barren Islands, Augustine Island, and the Alaska Peninsula from False Pass to the mouth of Reindeer Creek, thence following said creek and a line to the center of Aniakchak Crater, and including that portion of said peninsula consisting of the drainage to the Pacific Ocean south of a line following the divide from the center of Aniakchak Crater to the old portage from Kamishak Bay to Kakhonak Bay; thence along said portage on the boundary of fur district 2 to Kamishak Bay.

Fur district 4.—All the drainage to Bristol Bay, bounded on the south by the northern boundary of fur district 3, on the east by the western boundary of fur district 2, and on the north by a line beginning at Cape Newenham and extending along the summit of the divide separating the waters flowing northerly into Kuskokwim Bay and Kuskokwim River from those flowing southerly into Bristol Bay, to its intersection with the western boundary of fur district 2 at a point approximately 22 miles south of Merrill Pass.

Open seasons—Continued.	*Date inclusive*
Marten:	
In district 1	Dec. 16–Jan. 15.
In districts 2, 3, 4, 5, 6, and 8	No open season.
In district 7	Nov. 6–Feb. 20.
Muskrat:	
In district 1	Dec. 16–Apr. 30.
In districts 2, 3, and 4	Dec. 1–Apr. 30.
In districts 5 and 8	Dec. 1–June 10.
In district 6	Nov. 16–May 31.
In district 7	Nov. 6–May 31.
Mink, land otter, weasel (ermine), fox (red, cross, silver, white, blue), lynx:	
In district 1	Dec. 16–Jan. 15.
In district 2	Dec. 1–Feb. 29.
In districts 3 (see exception) and 4	Dec. 1–Jan. 31.
Exception: Mink, land otter, weasel, on Unimak Island in district 3	No open season.
In district 5	Dec. 1–Feb. 28.
In district 6	Nov. 16–Feb. 20.
In district 7	Nov. 6–Feb. 20.
In district 8	Dec. 1–Apr. 15.

Open seasons—Continued.	*Date inclusive*
Wolf, coyote, wolverene, black bear, marmot, ground squirrel (throughout Territory), and polar bear in districts 5 and 8	No close season.

Prohibited methods:[3][6] Unlawful to take or kill land fur animals with poison, by use of trap or device known as the "klips," steel bear trap, or any other trap with jaws having a spread exceeding 9 inches, by aid or use of a shotgun, fire, jacklight, pit lamp, searchlight, or other artificial light, or (except polar bear and, in districts 2 and 3, wolves and coyotes), by aid of a dog. No fur animal may be taken from its home or den by digging, smoking, or use of chemicals, and no home, house, den, or runway of a beaver or muskrat may be injured or destroyed. Traps may not be set within 25 feet of beaver house, or den, nor may beavers be taken with firearms.

Bag limits: Beaver, 10 a season in districts 1 and 7; 15 a season in districts 2, 4, 5, and 6. Marten, 10 a season in districts 1 and 7.

Licenses: Trapping: Nonresident, $50 (nonresident hunting large brown or grizzly bears must have registered guide); resident, $2 (not required of native-born Indians, Eskimos, or half-breeds who have not exercised right of franchise or severed their tribal relations). Alien, $100 (special license, issued by members of commission). Fur farm, $2. *Fur dealer:* Resident, $10. Nonresident citizen, or corporation, association, or copartnership organized under laws of Territory, or a State of United States, $100. Alien, or a corporation, association, or copartnership not organized under laws of Territory, or a State of United States, $500 (agents, nonresident citizen, $100; resident, $10). Licenses issued by members of commission, game wardens, and authorized agents. Licensed fur dealers must keep complete records of all fur transactions. Dealer's license not required of native-born resident Indian, Eskimo, or half-breed who has not exercised right of franchise or severed his tribal relations, or of a hunter or trapper to sell skins of fur animals he has lawfully taken or of fur farmer to sell skins of ani-

---

Fur district 5.—That portion of western Alaska draining to Kuskokwim Bay, Bering Sea, Norton Sound, and Kotzebue Sound, bounded on the east by a line beginning at Cape Newenham and extending along the divide separating the waters flowing into Kuskokwim Bay and Kuskokwim River from those flowing into Bristol Bay and the Tikchik Lakes; thence along the divide separating the waters flowing into the Tuluksak River and Whitefish Lake from those flowing into the Aniak River and Swift Creek; thence to a point on the Kuskokwim River opposite the mouth of the first stream on the north bank above Ohagamut; thence across the Kuskokwim River and following the center of said first north-bank stream above Ohagamut to its head; thence along the divide separating the waters of Paimute Portage flowing into Big Lake from those flowing into the Yukon River; thence to a point on the Yukon River 15 miles below Paimute Village; thence following down the south bank of the Yukon River to a point 5 miles below Dogfish Village; thence across the Yukon River to Mount Chiniklik; thence along the divide separating the waters flowing into the Stuyahok River from those flowing into the Kuyukutuk River; thence continuing along said divide separating the waters flowing easterly into the Yukon River from those flowing westerly into Norton Sound; thence continuing along said divide separating the waters flowing into the Koyukuk River from those flowing into Kotzebue Sound to the summit of the divide separating those flowing into the Colville River from those flowing into the Noatak River; thence westerly along the divide separating the waters flowing north into the Arctic Ocean from those flowing south into the Noatak and Kukpuk Rivers to the coast at Cape Lisburne.

Fur district 6.—All of the watershed of the Tanana River, the upper Copper River, part of the lower Yukon River and the upper Kuskokwim River, bounded on the east by the international boundary, on the south by the northern boundaries of fur districts 2 and 4, on the west by the eastern boundary of fur district 5, and on the north by a line beginning at International Boundary Monument No. 146 and following the divide separating the waters of the north fork of the Ladue River from those of the Ladue River; thence along the divide separating the waters flowing northerly into the Yukon River from those flowing southerly into the Tanana River, through Far Mountain, Twelve Mile Summit, and Wickersham Dome; thence along the divide separating the waters flowing easterly into Beaver Creek from those flowing westerly into Hess Creek; thence along the divide separating the waters flowing southwesterly into Hess Creek from those flowing northerly into the Yukon River; thence along the divide separating the waters flowing southerly into Waldron Creek from those flowing northerly into the Yukon River, to the site of old Fort Hamlin; thence across the Yukon River to the divide separating the waters flowing northerly into the Dall River from those flowing southerly into the Ray River; thence along the divide separating the waters flowing northerly into the Kanuti River from those flowing southerly into the Yukon River; thence along the divide separating the waters flowing westerly into the Koyukuk River from those flowing southerly into the Melozitna River; thence along the divide separating those waters flowing into the Koyukuk River above the upper end of Treat Island from those entering below said point, to the Koyukuk River; thence across the Koyukuk River at the upper end of Treat Island and northwesterly along the divide separating the waters flowing easterly into the Hogatza River and Koyukuk River from those flowing southerly into the Koyukuk River, to Cone Mountain; thence along the divide separating the waters flowing easterly into the Hogatza River from those flowing westerly into the Dakli River to the intersection with the eastern boundary of fur district 5.

Fur district 7.—All the drainage to the upper Koyukuk and upper Yukon Rivers bounded on the east by the international boundary, on the north by the summit of the Brooks Range, on the west by the eastern boundary of fur district 5, and on the south by the northern boundary of fur district 6.

Fur district 8.—The Arctic coast of Alaska consisting of all the drainage to the Arctic Ocean north of the northern boundaries of fur districts 5 and 7.

[3] Unlawful to kill land fur animals when fur is unprime; killing of all land fur animals in Mount McKinley National Park, Katmai and Glacier Bay National Monuments, or in Eyak Lake closed area, and on Kruzof and Partofshikof Islands, and, except under permit from Secretary of Agriculture, on national bird and game refuges, or, except by occupant, on any island under lease or permit for fur-farming purposes is prohibited.

[6] Unlawful to feed to a fox or other fur animal held in captivity any part of a game animal or bird other than an eagle, a raven, crow, hawk, owl, or cormorant, except waste parts such as hides, viscera, and bones.

mals raised by him, and a person not engaged or employed in fur trade, may buy furs for his own use, but not for sale.

Licensees, within 30 days after expiration of license, must report to game commission, Juneau, number and kind of fur animals taken, purchased, or otherwise procured under license. Fur dealer and fur farmer must also comply with Territorial laws and keep records.

Possession and sale: No restrictions on prime skins legally taken except that skins of beavers and martens must be presented to commission or authorized agent, with affidavit showing lawful taking for sealing, within 90 days (30 days in fur district 1) after the close of open season in area where taken. Unlawful to possess unsealed beaver or marten skins after expiration of above periods, or to barter or sell unsealed beaver or marten skins. Fur dealers required to be licensed (see Licenses). Blue-fox skins must be tagged or branded before being sold.

Shipment and export: No restrictions on prime skins legally taken, but no person engaged in fur farming or the fur trade as a dealer or agent shall possess or transport such furs without a license. Skins of beaver and marten legally acquired and properly sealed may be possessed and transported at any time, but packages containing beaver and marten skins must be marked to show serial numbers of seals. Skins of beavers shipped or transported out of Territory must be reported to commission. Blue-fox skins (other than those raised on farms having a registered brand and branded with such brand) whether acquired in Territory or imported, must be tagged (fee, $1.50) by United States commissioner.

Shipments must be accompanied by statement showing number and kind of skins therein and that no unprime skin is included, such statements to be taken up and mailed to Alaska Game Commission, Juneau, by collectors of customs when by freight or express, by postmasters, when by parcel post, or direct to commission by shipper when by other means.

Nonresident citizen or alien may export 2 large brown or grizzly bears under hunting license and affidavit of lawful killing.

Resident may export for mounting and return within one year, trophies of large brown or grizzly bears legally killed, under permit, fee $1 for each trophy. Resident citizen removing from Territory may export large brown or grizzly bears legally acquired, under permit, fee $5 for each specimen. (See Licenses.)

Propagation: License, fee $2, must be obtained from Alaska Game Commission to conduct a fur farm or to possess fur animals for propagation. Fur animals may be taken for propagation under permit from Secretary of Agriculture and countersigned by executive officer of commission. Blue-fox farmer must register brand, fee $10.

On Aleutian Islands Reservation permits to use island for fur farming and to trap animals for breeding purposes must be obtained from Department of Agriculture.

Public lands in Alaska for fur-farming purposes may be leased from Department of Interior under act of July 3, 1926, and regulations thereunder.

Bounties: Wolf, $15; coyote, $15; eagle, $1; hair seal (southeastern Alaska, east of 152d meridian), $2 (paid by Territory).

ARIZONA

Open seasons:	*Dates inclusive*
Beaver [7]	No open season.
Bear (hunting) (no open season south of Gila River)	Oct. 16–Nov. 15.
Muskrat, raccoon, opossum, otter	Nov. 1–Mar. 1.
Other fur and predatory animals [8]	No close season.

Bag limits: One bear a season.

Prohibited methods: Muskrat, raccoon, opossum, and otter may only be taken with guns or traps. Bear may not be trapped. Use of poisonous or stupefying substances prohibited.

Licenses: Hunting license required for bears (fees, nonresident, $35; resident, $2.50). Trapping licenses: Nonresident, $25; resident required to procure license, but no fee charged. Issued by warden, designated deputies, and clerks of boards of supervisors. Traps must be inspected daily. Licensee must keep record of his catch and report to commission on or before January 10 each year. Unlawful to disturb or remove traps of licensed trappers on public domain or on lands where they have permission to trap. Traps must be tagged with metal tag showing number of owner's license. Alien prohibited from trapping.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: Export of beaver skins prohibited. No other restrictions on skins legally taken, but packages must be marked with name and address of consignor and consignee and an accurate statement of contents. License coupon or shipping permit from commission must be attached to each shipment. Shipment by parcel post prohibited.

Miscellaneous: Unlawful to use fish or the flesh of any game bird or animal for trap bait.

Propagation: Under permit from State game warden, fur-bearing and predatory animals may be kept for propagation, exhibition, or sale.

Bounties: Payment of bounties is optional with county boards of supervisors.

ARKANSAS

Open seasons:	*Dates inclusive*
All fur animals (see exceptions)	Dec. 1–Jan. 31.
Exceptions: Bear, beaver	Nov. 9–Nov. 14. Dec. 20–Jan. 1.
Fox (trapping), in Arkansas, Ashley, Benton, Bradley, Clark, Clay, Cleveland, Columbia, Craighead, Crittenden, Dallas, Desha, Drew, Faulkner, Garland, Grant, Green, Hempstead, Hot Spring, Jefferson, Johnson, Lafayette, Lincoln, Logan, Miller, Mississippi, Monroe, Montgomery, Nevada, Ouachita, Perry, Phillips, Pike, Pulaski, Saline, Scott, Sebastian, Sevier, Union, Washington, White, and Yell Counties	No open season.[9] [10]
Wolf, bobcat, coyote	No close season.

Prohibited methods: Use of deadfalls, poisons, explosives, or chemicals, and of traps larger than size 1½ prohibited. Unlawful to cut den trees without consent of owner, or to set traps in paths, trails, or runways commonly used by persons, domestic animals, or poultry. Traps must be visited each day.

Licenses: Nonresident, $50. Resident, using more than 12 traps, $20; resident over 18 may use 12 or less traps under resident hunting license (fee, $1.10); and resident under 18 may use 12 or less traps without license.

Bag limit: One bear, 2 beaver, a season.

Possession and sale: Sale or possession of pelts taken in State prohibited, except between December 1 and February 10. Fur dealer required to file report of pelts on hand February 10 and obtain permit to possess or sell pelts during close season.

Shipment and export: No restrictions, except fur dealers must report shipments within or without State.

Propagation: State game and fish commission may issue permits to breeders of game and fur animals under such regulations as it may prescribe.

Bounties: None paid.

---

[7] *Arizona:* Under permit of commission beaver doing damage on private property may be taken, but skins of beaver so taken must be turned over to commission for disposition.

[8] Mountain lion, wolf, fox, coyote, lynx, wildcat, skunk, or other obnoxious animals may be taken on State game preserves only under regulations of State game warden. Owner may protect his premises from depredations of predatory and fur animals, except beavers, at any time.

[9] *Arkansas:* Chasing foxes by dogs permitted at any time. Foxes so caught may be killed and pelts sold by sheriff of county for benefit of school fund of district in which taken.

[10] Fur animals found destroying crops or poultry may be killed at any time.

CALIFORNIA

Open seasons: [11] [12]	*Dates inclusive*
Black or brown bear	Nov. 15–Feb. 29.
Beaver,[13] muskrat, river otter, fisher, pine marten, mink, skunk, fox, kit fox, ring-tailed cat, raccoon, wolverene (see exception)	Nov. 15–Feb. 29.
Exception: Predatory animals, in districts 2, 2½, 3, 4, 4¾	No close season.

Prohibited methods: Unlawful to use poisons or gun larger than No. 10 gage or trap with sawtooth or spike jaws in taking fur animals. Unlawful to take fur animals other than by trap or gun, or by use of dogs.

Licenses: Citizen, $1; alien, $2; issued by fish and game commission. License issued free to veterans of Civil War. Duplicate license issued only on affidavit of applicant that original has been lost or destroyed. License not required of persons under 18. Licensed trappers required to report before July 1 number of each species taken, with name and address of person or firm to whom sold or shipped. Licensee must exhibit license and furs to wardens or peace officers upon demand. Unlawful to disturb or remove traps of licensed trapper who is trapping on the public domain or on lands where he has permission to trap.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions.

Propagation: Fur animals may be raised in captivity under regulations of the commission.

Bounties: [14] Mountain lion, female, $30, male, $20; paid by fish and game commission. Boards of supervisors of counties may fix rate and pay bounty on coyote, wildcat, fox, lynx, bear, or mountain lion. Many counties now pay bounty on some of these animals, especially on coyotes.

COLORADO

Open seasons:	
Beaver	No open season.[15]
All other fur animals	No close season.[16]

Prohibited methods: No restrictions.

Licenses: Hunting license required to trap: Resident. General, $5; limited, $2 (for coyote, mountain lion, wolf, bobcat, lynx); nonresident, big game, $25; small game, $5; issued by commissioner, county clerks, and other agents. Taxidermist, $5. Unnaturalized resident not permitted to hunt, capture, or kill any wild bird or animal.

Possession and sale: No restrictions.

Shipment and export: No restrictions.

Miscellaneous: Use of game or fish for trap bait prohibited.

Propagation: No restrictions, except as to beavers and game animals.

Bounties: Mountain lion, $50, from State game fund.

CONNECTICUT

Open seasons: [17]	*Dates inclusive*
Muskrat	Nov. 1–Mar. 31.
Raccoon	Oct. 21–Dec. 31.
Fox, weasel	No close season.
Skunk, otter, mink, and other fur animals	Nov. 1–Mar. 15.

Prohibited methods: Unlawful to trap with scented baits or to take animals with snare or similar device, to use steel traps having more than 6-inch spread of jaws, or any steel trap having teeth. Unlawful to set steel trap except in water, in burrow of a wild animal, or on a pole at point 8 or more feet from ground, but on own land steel traps may be set any place within 100 yards of a permanent building, or on cultivated land owned or occupied by trapper. Poisoning fur animals prohibited. Unlawful to disturb muskrat house or den or to hunt muskrats from sunset to sunrise. Unlawful to take fur animals by use of dynamite or other explosive, gas, smoke, poison, or chemical, or by digging from burrow or den. Traps must be stamped with name of user, and must be visited at least once in 24 hours.

Licenses: Resident trapping license, under 16 years of age, $2.35; over 16 years of age, $5.35. Taxidermist, $5; issued by board of fisheries and game. Alien may set and tend traps, during open season, on own lands used for agricultural purposes, and on which he is actually domiciled, without license. Resident citizen may trap on own lands during open season without license. Nonresident debarred from trapping. Licensee required to wear button and to report number of animals trapped each season. Unlawful to trap on lands of another without consent of owner or lessee.

---

[11] *California:* Written permission from board of fish and game commissioners required to trap or hunt predatory animals (includes all fur animals except bears and seals) on State game refuges. Trapping licenses are not required, and there are no restrictions on taking of predatory animals in districts 2, 2½, 3, 4, 4¾.

[12] Of the 72 fish and game districts created under the act of 1917, as amended in 1929, 9 (1, 1½, 1¾, 2, 2½, 3, 4, 4½, and 4¾) are properly hunting districts; 14, 15, 23, 24, and 25 are fishing districts but are open to hunting; of the other 58 districts, 36 are game refuges, 1 a fish reservation, and 21 are commercial fishing districts.

District 1 comprises the eastern half of the Sacramento and San Joaquin Valleys, including all counties not included in districts 1½, 1¾, 2, 2½, 3, 4, 4½, and 4¾.

District 1½ comprises the counties of Del Norte, that part of Siskiyou west of Pacific Highway and Weed-Klamath Falls Highway.

District 1¾ comprises Modoc and Lassen Counties, and Siskiyou County east of Southern Pacific Railroad and Klamath River.

District 2 comprises that part of State south of Humboldt and Tehama Counties, west of Sacramento River and north of San Francisco Bay, including counties of Glenn, Colusa, Yolo, Solano, Napa, Lake, Sonoma, and Marin, and that portion of Mendocino County not included in district 2½.

District 2½ comprises townships in Mendocino County bordering on Pacific Ocean, except township 11 north, ranges 15 and 16 west, and townships 13, 14, 15, 16, 17, and 18 north, range 16 west.

District 3 comprises region around southern portion of San Francisco Bay and coast counties south of the Golden Gate as far as Ventura, including counties of Contra Costa, Alameda, San Mateo, Santa Clara, San Francisco, Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, and Ventura; also San Benito and western half of San Joaquin, Stanislaus, Merced, Fresno, Kings, and Kern Counties.

District 4 comprises counties in southern California, namely Los Angeles, Orange, Riverside, and San Bernardino.

District 4½ comprises counties of Mono and Inyo.

District 4¾ comprises San Diego and Imperial Counties.

Districts 23, 24, and 25, all located in district No. 1, are as follows:

District 23 comprises drainage area of Lake Tahoe and Truckee River, and headwaters of American and Rubicon Rivers, in counties of Placer and Eldorado.

District 24 comprises drainage area of Silver, Twin, Blue, Meadow, and Wood Lakes in counties of Alpine and Amador.

District 25 comprises drainage area of Lake Almanor in counties of Plumas and Lassen.

[13] Beavers doing damage to levees or other protective works in reclamation, levee, or swamp-land districts may be taken under permit from commission, such taking to be reported within 10 days, when commission issues permit for disposition of skins.

[14] For information in regard to bounties in any county, application should be made to county clerk.

[15] *Colorado:* Owner of property being damaged by beavers may be permitted to kill them under such regulations as may be provided concerning disposition of skins by State game and fish commissioner.

[16] A permit from State game and fish commissioner is necessary to take mountain lion, wolf, coyote, fox, lynx, wildcat, mink, marten, or wolverene on State game refuges.

[17] *Connecticut:* Fox, skunk, raccoon, wildcat, mink, or weasel may be hunted or trapped on State game preserves only by superintendent of fisheries and game or persons designated by him. Fur animals may be killed at any time for protection of property.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: No restrictions on possession or sale of fur animals kept in captivity under license (fee, $2).

Bounties: Any town may pay bounty of $5 for wildcat, fox, rattlesnake, copperhead snake, and $1 for weasel, woodchuck, and wild Belgian or German hare killed within its limits.

DELAWARE

Open seasons: [18]	*Dates inclusive*
Fox	Oct. 1–Apr. 30.[18]
Skunk, mink, otter, muskrat	Dec. 1–Mar. 10.[19]
Raccoon, opossum	Oct. 15–Jan. 15.

Prohibited methods: Unlawful to use pitfall, deadfall, scaffold, cage, snare, trap, net, pen, baited hook, or baited field, or any other similar device, or any drug, poison, chemical, or explosive for taking animals protected by State laws, except muskrat, skunk, mink, and otter. Traps or other devices unlawfully set are subject to confiscation. Unlawful to destroy nest, den, or lair of any animal protected by law; to kill raccoon or opossum, or to destroy, break, or interfere with den or lair of raccoon or opossum between one hour before sunrise and one hour after sunset. Unlawful to hunt, kill, take, or destroy any protected animal, except muskrat, skunk, mink, and otter, while ground is covered with snow. Unlawful to shoot at or destroy any fox while it is being chased by a dog. Muskrats may not be taken during time any flood or freshet may cause them to leave their usual places of shelter and protection, nor may they be shot at night, hunted with a dog, or taken by method commonly known as "nailing," or by use of "diving" or box trap.

Licenses: Hunting licenses required: Nonresident, $15.50; resident, $1.10 (not required in county of residence nor on own land); issued by commission. Permission of owner required to take or kill muskrats on land or marsh of another.

Possession and sale: Unlawful to sell fox or fox hide. No other restrictions.

Shipment and export: Unlawful to export fox or fox hide. No other restrictions.

Propagation: No restrictions, provided a permit is obtained from chief game and fish warden (fee, $1). A limited number of wild fur or game animals for propagating purposes may be taken under permit.

Bounties: Board of game and fish commissioners may pay bounties on unprotected birds.

FLORIDA

Open seasons: [20]	*Dates inclusive*
Beaver	No open season.
Muskrat, raccoon, mink, otter, civet cat (see exception)	Dec. 1–Feb. 28.
Exception: In Collier County	Nov. 20–Feb. 14.
Wildcat, weasel, skunk, panther, opossum, fox (red, gray), bear, bobcat (see exception)	No close season.
Exception: In Collier County	Nov. 20–Feb. 14.

Prohibited methods: Unlawful to use poison except within curtilage around home. Traps must be stamped with name and address of owner and visited once daily. Traps set in open must be properly safeguarded. Unlawful to use steel traps in Franklin County.

Licenses: Resident, $3.25 (county of residence); $10.50 (county other than county of residence); $25.50 (state-wide license). Nonresident, $25.50 (county); $100.50 (state-wide). Alien, $50.50 (special, issued by commissioner). Not required of residents 65 years of age, resident Confederate veterans entitled to Florida pension, nor of children under 15. Issued by county judge. Written permission of owner required to trap on inclosed lands of another. Fur dealer: Resident, $10 (local); $100 (state-wide), and $5 for each agent or buyer employed; nonresident, $500; issued by State game commissioner. Reports required of licensed trappers and fur dealers.

Possession and sale: Skins legally taken may be possessed, bought, and sold during open season and for 30 days thereafter, except fur dealers may handle lawful skins at any time.

Shipment and export: Skins legally taken may be shipped and exported during open season and for 30 days thereafter. Fur dealers may handle lawful skins at any time.

Propagation: No legislation.

Bounties: None paid by State; county commissioners in Pinellas County authorized to pay bounty on snakes, skunks, hawks, and crows.

GEORGIA

Open seasons: [21]	*Dates inclusive*
Beaver, mink, otter, bear, muskrat, raccoon	Nov. 20–Feb. 1.
Opossum	Oct. 1–Feb. 1.
Fox (red, gray)	Sept. 1–Jan. 31.
Other fur animals	No close season.

Prohibited methods: Fox dens protected during close season. Fox, skunk, or wild cat may not be taken by trap, deadfall, or similar device. Use of steel traps prohibited except in salt marshes and islands on coast.

Licenses: None required. Permission of owner required to trap on lands of another.

Possession and sale: Prohibited during close season. Dealers must make such reports as may be required by commission.

Shipment and export: No restrictions.

Propagation: Permit from commissioner required to possess fur animals for propagation.

Bounties: None paid.

HAWAII

Hawaii has no wild animals valuable for fur. There are no restrictions on the propagation of fur animals, except that mongooses and rabbits may not be kept or bred. Pet rabbits may be raised if kept in confinement.

IDAHO[22]

Open seasons: [23]	*Dates inclusive*
Beaver	No open season.[24]
Marten, fisher, otter, mink, raccoon, fox, muskrat (see exceptions)	Dec. 1–Feb. 29.
Exceptions: Muskrat, in Bear Lake and Caribou Counties and Grays Lake in Bonneville County	Apr. 1–May 10.
Muskrat, in Jefferson County	Dec. 1–Mar. 15.
Other fur and predatory animals	No close season.[23]

Prohibited methods: Unlawful to destroy houses, dams, or other structures erected by fur animals.

Licenses: Resident, $5; nonresident, $25; alien, $50; issued by warden, deputy, or authorized agent. Licensed trapper must make verified report at end of season or within 90 days thereafter, of number and kind of fur animals caught, where sold, and price received. Unlawful to destroy, disturb, or remove traps of licensed trapper.

---

[18] *Delaware:* Owners may kill foxes at any time when destroying poultry; other fur animals may be killed at any time when destroying property.

[19] In New Castle County, on embanked meadows may be taken from Dec. 1 to Mar. 20.

[20] *Florida:* Animals destructive of crops, game, fowl, or stock may be killed on own property at any time under permit from State game commissioner.

[21] *Georgia:* Fur animals destroying property may be killed at any time.

[22] *Idaho:* State fish and game warden may close season in any locality on any species of fur-bearing animal threatened with extinction. Under permit of State warden, persons may protect their own premises from depredations of fur animals, except that bears doing damage may be destroyed without a permit.

[23] All trapping is prohibited on State game preserves, except that certain predatory animals may be killed thereon by deputy game wardens and persons authorized by State game warden.

[24] State game warden may grant permits to take beavers and muskrats in close season, when doing damage to irrigation canals, crops, etc., or authorize deputy warden or State trapper to take such animals. Pelts of animals taken must be turned over to warden for sale. Possession of beaver hides otherwise prohibited.

Possession and sale: [24] Skins of animals legally taken, within or without State, may be possessed or sold at any time. Unlawful to possess without permit fur animals, or hides thereof, on which there is no open season.

Shipment and export: No restrictions.

Miscellaneous: Unlawful to use flesh of any game animal, bird, or fish for trap bait. Unlawful to destroy houses, dams, or other structures erected by fur animals, except under permit of State warden.

Propagation: Fur-farm permit required—fees, $5 each for mink, muskrat, marten, and skunk, and $12.50 for beaver; permittee required to make report. Applicant for permit required to deposit $100 to cover expenses incident to inspection of premises.

Bounties: None paid.

ILLINOIS

Open seasons: [25]	*Dates inclusive*
Raccoon, skunk, opossum, fox, muskrat, mink—	
Northern zone	Nov. 1–Feb. 15.
Central zone	Nov. 15–Feb. 1.
Southern zone	Nov. 15–Jan. 15.
Otter	Nov. 15, 1933.
Other fur animals	No close season.

Prohibited methods: Houses, dens, and den trees of fur animals protected, except where they obstruct public or private ditches or watercourses. Unlawful to use spear or similar device for hunting or taking fur-bearing animals, or explosives, chemicals, or mechanical devices or smokers of any kind to drive them out of their burrows, dens, or houses, or to set trap within 10 feet of muskrat house, or use firearms in taking muskrats. Use of automobile or vehicle propelled by mechanical power, or the lights thereof, or ferret, weasel, guinea pig, or rat, in hunting or taking fur-bearing animals prohibited.

Licenses: Resident citizen, $2; nonresident citizen, $10.50; issued by county, city, or village clerk. License not required of landowners and tenants and members of families to trap during open season on the lands on which they reside. License not issued to a person under 16 without written consent of parent or guardian, nor to alien. Licensee must report monthly, not later than the 5th, all hides of fur animals taken, sold, shipped, or dealt in during period November to March, inclusive, together with names and addresses of persons to whom sold or shipped. Permission from owner, agent, or occupant required to trap on land of another.

Fur buyer, $10; wholesale fur buyer, $50; issued by department of conservation. Buyer must keep daily register of all furs purchased. Taxidermist, $5.

Possession and sale: Possession of green hides (hides that have not been tanned) of fur animals permitted in each zone during the open season and 10 days thereafter. No other restrictions on possession and sale.

Shipment and export: No restriction on skins legally taken and possessed.

Propagation: Permit required to conduct a fur farm on which protected animals are reared; fee, $2; issued by conservation department. Permit to breed and raise ferrets, fee, $10.

Bounties: None paid by State; counties may pay bounty on groundhog and crow.

INDIANA

Open seasons: [26]	*Dates inclusive*
Raccoon, fox, opossum, skunk, mink, muskrat	Nov. 15–Jan. 15.
Other fur animals	No close season.

Prohibited methods: Traps set on land of another must be placed at least 18 inches within burrow or hollow log and must be visited at least once in each 36 hours. Muskrat houses protected except when obstructing ditches or watercourses. Unlawful to dig out fur bearing animals or to chase them from their burrows by use of smoke, fumes, or chemicals.

Licenses: Resident, $1; nonresident, $15.50; issued by county clerk and by superintendent of fisheries and game and his agents. Honorably discharged soldiers, sailors, and marines who are resident citizens of State may procure permit without cost to trap during open season; resident landowners, children living with them, and tenants may trap without license on lands occupied by them. Written consent of owner, occupant, or lessee required to trap on land of another. Fur buyer's license required for buying, selling, or bartering hides, skins, or furs of fur animals. Residents, $10; nonresidents, $50. Issued by department of conservation. Licensee must report all transactions within 15 days from close of season.

Possession and sale: Possession of fur animals or green hides prohibited during close season, except that fresh skins may be disposed of during first five days of close season.

Shipment and export: No restrictions on skins legally taken and possessed.

Propagation: All animals raised in captivity are considered domestic stock, and owner may possess, sell, ship, transport, or otherwise dispose of them without regard to laws regulating killing and disposition of wild animals. Fur animals, lawfully acquired, may be possessed for breeding purposes during close season. An inspection certificate, fee $5, must be obtained from department of conservation. Permit required to possess or harbor ferrets; fees, $10 for each single ferret, and $5 for each additional one; issued by conservation department.

Bounties: Boards of county commissioners may pay bounty on wolf, fox, groundhog, crow, owl (except screech owl), or hawk (except sparrow hawk). Bounty law on fox effective only during open season.

IOWA

Open seasons: [27]	*Dates inclusive*
Northern zone: [28]	
Beaver, mink, otter, muskrat, skunk, fox (red), civet	Nov. 10–Jan. 15.[29]
Raccoon, opossum	Oct. 20–Dec. 1.
Southern zone: [28]	
Beaver, mink, otter, muskrat, skunk, fox (red), civet	Nov. 20–Jan. 15.[29]
Raccoon, opossum	Nov. 1–Dec 20.

Prohibited methods: Use of poison and ferrets prohibited; skunk and fox dens and muskrat houses may not be injured or destroyed. Beaver, otter, mink, and muskrat shall not be taken with spear or shotgun.

---

[24] See footnote on p. 10.

[25] *Illinois.* Northern zone comprises Henderson, Warren, Knox, Peoria, Woodford, Livingston, and Iroquois Counties and all counties north thereof. Southern zone comprises Madison, Bond, Fayette, Effingham, Jasper, and Crawford Counties and all counties south thereof. Central zone comprises all counties not included in northern or southern zones.

[26] *Indiana:* Protected fur animals may be killed at any time on own premises to protect property. Destruction of such animals, however, must be reported to department of conservation within five days, and if hides are preserved, they must be sent to department or arrangements made for their disposition.

[27] *Iowa:* Fur animals may be destroyed at any time to protect public or private property.

[28] Northern zone comprises counties of Monona, Crawford, Carroll, Greene, Boone, Story, Marshall, Tama, Benton, Linn, Jones, and Jackson and counties north thereof. Southern zone comprises rest of State.

[29] Upon petition of 100 residents in any county, State fish and game warden may extend the season on red foxes in said county 30 days.

Licenses: Resident, 10 traps or less, $1; 11 to 35 traps, $10; nonresident or resident alien, 35 traps or less, $25; issued by county recorders. Fur dealers or buyers, $10 (bond, $500); issued by State game department. License not issued to persons under 18 without written consent of parent or guardian. Owners of farm lands, their children, and tenants or employees, may trap on own land without license during open season. Permission of owner, occupant, or agent required to hunt or trap fur animals on cultivated or inclosed land of another. Licensee must report within 10 days number of fur animals captured during open season.

Possession and sale: Skins of fur animals and parts thereof lawfully taken, within or without State, may be possessed and sold during open season and 10 days thereafter, or at any time on proof of lawful possession, or under permit of fish and game department; provided that green hides in process of manufacture may be possessed at any time.

Shipment and export: Skins of protected fur animals legally taken and duly tagged (tags issued by fish and game department on request), may be exported during open season and first 10 days of close season.

Propagation: Breeder's permit, fee $2, must be obtained from State game warden to propagate protected fur animals.

Bounties: Boards of supervisors of counties may allow bounty on crow, groundhog, pocket gopher, or rattlesnake.

KANSAS

Open seasons: [30]	*Dates inclusive*
Beaver, muskrat, skunk, mink, opossum, raccoon, civet cat, badger, fox (red, gray, prairie)	Nov. 16–Jan. 31.[31]
Otter	No open season.

Prohibited methods: Ferrets, poisons, or use of smoke, guns, or other devices for forcing smoke, gas, or liquids into holes, dens, or runways, prohibited. Unlawful to destroy houses, dens, or runways of fur animals. Unlawful to set or maintain more than 30 traps, which must be visited daily.

Licenses: Resident, $1 issued by county clerk. Nonresidents not permitted to trap. Consent of owner or lessee required to hunt or kill wild animals on land of another. Fur dealer, resident, $10; nonresident, $25; issued by forestry, fish, and game commission. Licensee required to keep open records and file report of each purchase of furs.

Possession and sale: No restrictions on licensees for skins legally taken. Possession permitted during open season and first 10 days of close season.

Shipment and export: No restrictions on skins legally taken. May not be shipped except during open season and 10 days thereafter, but licensed dealers may make shipments out of season under special permits.

Propagation: Quadrupeds raised in wholly inclosed preserve under license (fee, $2) may be sold at any time for breeding or stocking purposes. Shipments must be tagged to show number and kind of animals, number of breeder's license, and names and addresses of consignor and consignee, and be accompanied by permits from State warden. Licensee required to make annual report of number of animals in possession. Wild animals may be captured during open season and thereafter had in possession for breeding purposes, under rules and regulations of State warden.

Bounties: Coyote, $2; crow, pocket gopher, 10 cents each; paid by county. County commissioners may pay 10 cent bounty on jack rabbits.

KENTUCKY [32]

Open seasons: [32]	*Dates inclusive*
Beaver, mink, raccoon, fox, otter, opossum, skunk	Nov. 15–Dec. 31.
Other fur animals	No close season.

Prohibited methods: Traps must be set 18 inches or more within a hole, cave, or hollow log, and must be visited within each 36 hours.

Licenses: Resident, $1; nonresident or alien, $10.50. Issued by county clerk. Resident landowner, tenant, and members of family may hunt or trap on own land during open season without license. Written consent of owner or lessee required to trap on lands of another.

Possession and sale: Possession of green skins during close season prima facie evidence of unlawful taking.

Shipment and export: No restrictions on skins legally taken.

Propagation: No legislation.

Bounties: Crow, 15 cents each; paid by county fiscal courts.

LOUISIANA

Open seasons: [33]	*Dates inclusive*
Bear [34]	Oct. 15–Jan. 5.
Muskrat, mink, otter, raccoon, skunk, civet, opossum, wolf, wildcat, fox, weasel, alligator (except alligator in coast parishes and Orleans, St. Charles, St. John, and St. James, no close season)	Nov. 20–Feb. 5.
Beaver	No open season.

Prohibited methods: Unlawful to trap bear or fox at any time. Wolves, wildcats, cougars, and, in parishes named above, alligators are outlawed, and may be hunted and killed at any time by licensee, but may be trapped only during open season on fur animals; use of firearms for taking other fur animals prohibited. Gigs, spears, pitchforks, or like devices, and explosives, chemicals, mechanical devices, or smokers to drive fur animals from dens or houses prohibited. Unlawful to destroy muskrat houses and nests, lairs, or dens of other fur animals or to set traps within 10 feet thereof.

Bag limits: One bear a day, five a season.

Licenses: Resident (trapping only; authorizes not more than 250 traps in parish where holder traps), $2; issued by tax collector. Traps must be visited daily. Trapping licenses not issued to nonresidents. Resident fur buyer, $10; resident dealer, $50; nonresident buyer, $50; nonresident dealer, $250; issued by department of conservation. Hunting license required to take bear, fox, wolf, wildcat, or cougar: Nonresident, $50; resident, $1. Alligator hunters required to obtain trapping license. Licensed trapper within 15 days after close of season must report to department of conservation number and kind of animals taken under license.

Possession and sale: Possession of raw or undressed furs prohibited from March 1 to November 19. Unlawful to possess raw furs without a license. Dealer must file sworn monthly statement of kind and number of pelts bought in State, and showing pelts shipped out of State.

Shipment and export: Tax, otter, 25 cents; mink, raccoon, 5 cents; alligator, 1 to 3 cents; and all other pelts, 1 cent each, must be paid on all pelts taken before being shipped out of State. All shipments must bear tags furnished by conservation department; no furs or alligator skins may be shipped out of State except by holder of a dealer's license or by a trapper shipping his own catch; export of bear prohibited, except under written permission of commissioner. Dealer must make sworn monthly report of pelts shipped out of State.

Propagation: Fur animals raised in captivity under license (fee, $10) may be sold at any time for stocking or breeding purposes, but may not be killed and pelted except during the open season. Fur animals for breeding purposes may not be captured except under restrictions specified in permits issued by department of conservation. Permit from department required to import wild quadrupeds into State or to export from State.

Bounties: None paid.

---

[30] *Kansas:* Forestry, fish, and game commission may further restrict seasons and methods of taking.

[31] Owner or legal occupant of land may destroy these animals at any time when they are destroying poultry or damaging other property.

[32] *Kentucky:* Fur animals may be killed at any time on own premises to protect property.

[33] *Louisiana:* Unlawful to take young of any fur animal the pelt of which has no regular market value.

[34] Bears and fur animals may be killed at any time on one's own land when actually damaging property.

MAINE

Open seasons:[35]	*Dates inclusive*
Beaver[36]	No open season.
Muskrat,[36] [37] in Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties	Mar. 20-Apr. 20.
In rest of State	Nov. 1-Nov. 30. Apr. 1-Apr. 30.
Other fur animals in Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties	Nov. 16-Jan. 31.[38]
In rest of State	Oct. 16-Jan. 31.[38]
Bobcat, Canada lynx or loup cervier, porcupine	No close season.

Prohibited methods: Unlawful to use snare, swivel, pivot, or set gun, or to put out poison or stupefying substance for any animals. Flesh of protected game may not be used as bait. Traps may not be set within 25 feet of a muskrat or beaver house. Unlawful to molest or destroy beaver or muskrat houses. Unlawful to dig out a fox den or remove foxes therefrom, except in private fox ranches; or to set traps (except "water sets") within half a mile of compact or built-up portion of a city or village outside of own land. A bear trap must be inclosed in a "hut," or surrounded with two strands of barbed wire, 5 yards distant from trap, 4 and 5 feet, respectively, from ground.

Licenses: Trapping—resident, $5 (in organized township); $10 (State); nonresident and alien, $50. Not required of minors under 18, nor of residents or members of immediate family to trap on own cultivated land (except for beaver) in organized township. Issued by commissioner. Licensee, on or before December 31 of each year, must make such report as commissioner may require. Written consent of owner or occupant must be obtained before setting traps on cultivated lands of another in an organized or incorporated place; such traps must be visited at least once in every 24 hours, except water-sets for mink and muskrat, and any animals caught removed. Traps must be stamped or bear metal tag to show full name and address of trapper.

Beaver trapping in areas opened by commissioner permitted under $10 State license, but skins of beavers so taken must be sealed and stamped, fee $2 each.

Dealer in skins must be licensed (fee, State, $25); and must keep a record of transactions and forward same to commissioner of inland fisheries and game on or before December 31 of each year.

Possession and sale: Sale of beaver skins without seal of commissioner attached prohibited. No other restrictions on skins legally taken.

Shipment and export: Transportation of beaver skins without seal of commissioner attached prohibited. No other restrictions on skins legally taken.

Propagation: Breeder's license required to raise fur animals (fee, $5). No animals may be imported into the State for liberation without permit.

Bounties: Bobcat and Canada lynx (loup cervier), $20 each; paid by State; claim to be made within five days after killing or return from trip on which killing was done. Hedgehog, or porcupine (Maine forestry district October 15-April 1 only, paid by State), 25 cents, paid by town treasurer. Bear destroying valuable domestic animals in communities where bounty has been declared, $25.

MARYLAND

Open seasons:	*Dates inclusive*
Muskrat	Jan. 1-Mar. 15.
Raccoon, opossum (see exception)	Nov. 1-Jan. 31.
Exception: In Harford County	Nov. 1-Nov. 30.
Otter	No open season.
Other fur animals	No close season.[39]

Prohibited methods: Unlawful to take or kill muskrat in any manner, except by trapping, to dig for muskrat or in any manner molest or destroy any part of a muskrat house or den. Unlawful to hunt raccoon or opossum between sunrise and sunset, to shake or throw out from tree or hollow raccoon or opossum between Jan. 31 and Oct. 31; or to cut tree for catching or killing raccoon or opossum without consent of owner; use of steel traps or similar devices for catching raccoon or opossum prohibited. Possession of light for hunting muskrats at night prohibited.

Licenses: Hunting license required to trap: Resident, State, $5.25; county, $1.25; nonresident, $15.50 (fee, $5.50 for State license if applicant owns real estate in Maryland assessed at $500; $1.50 for county license in county where such real estate is located); issued by clerk or county circuit courts; in Baltimore city by clerk of court of common pleas. Licensee required to wear tag displayed on outer garment on middle of back and to carry license on person. License not issued to persons under 14 years of age without written request of parent or guardian. Owners, tenants, and their children may hunt on own land during open season without license.

Possession and sale: Possession of green hides of muskrat prohibited except from January 1 to March 25. Cured skins legally taken may be possessed at any time for business purposes.

Unlawful to buy, sell, or expose for sale, or transport from, any fox or fox hide in Baltimore, Cecil, Kent, Worcester, and Somerset Counties.

Shipment and export: No restrictions on skins legally taken and possessed.

Propagation: Game breeder's license (fee, $5) required.

Bounties: None.

MASSACHUSETTS

Open seasons:	*Dates inclusive*
Mink, otter, muskrat, skunk, raccoon (raccoon may also be hunted with dog and gun during October)	Nov. 1-Mar. 1.
Other fur animals	No close season.

Prohibited methods: Unlawful to open, disturb, or destroy muskrat house or to set trap within 10 feet thereof. Traps must be marked legibly with user's name and must be removed at end of open season. Poison may not be used to kill animals except rats, woodchucks, or other pests on one's own premises. The use of steel traps with spread of over 6 inches and "choke" traps with greater opening than 6 inches, and toothjaw traps, is unlawful, as is also the use of snares or, except by landowner, of scented baits. Traps must kill instantly, or capture alive unhurt. Except as otherwise stated, fur animals may only be taken by shooting or trapping, and traps may not be set in highways, cart roads, or paths.

Bag limits: Twenty raccoons a season.

Licenses: Nonresident citizen, $10.25. Nonresident residing in a State affording similar privileges to residents of Massachusetts, who owns real estate assessed at not less than $500, or who is a member of a hunting or fishing club or association incorporated prior to 1907, or who is a guest on written invitation of an incorporated club or association for hunting foxes, $5.25. Alien, $15.25 (applicant must have resided in State 10 days and own real estate therein to the assessed value of $500).

Resident citizen, $5.25. Not issued to minors under 15; and those between ages of 15 and 18, on written application and consent of parents, or guardians, may obtain trapping license, in discretion of issuing officer, fee $1.25. Resident may trap during open season without license on land owned or leased on which he is actually domiciled and which is used exclusively for agricultural purposes, and not for club, shooting, or fishing purposes. Duplicate of lost or destroyed license, fee, 50 cents. Licenses issued by city and town clerks.

---

[35] *Maine:* Any person may lawfully kill any wild animal, except beaver, destroying his property.

[36] Upon complaint of any water company that beavers or muskrats are polluting waters, or of any landowner that beavers are doing actual substantial damage to his property, commissioner of inland fisheries and game may declare special open season upon such waters and lands. (See Licenses.)

[37] Special laws on muskrats in certain localities. For detailed information apply to Commissioner of Inland Fisheries and Game, Augusta.

[38] Raccoons and skunks may be hunted at night, with dog or gun or rifle not larger than 0.22 caliber, and with kerosene light, Oct. 1-Dec. 15 in Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Oxford, Sagadahoc, Waldo, and York Counties only.

[39] *Maryland:* Foxes unprotected by State law, but many local laws govern the hunting, chasing or killing of them, information concerning which may be obtained from State game warden, Munsey Building, Baltimore.

Licensee must make written report of number of fur animals trapped during preceding year before securing new license.

Written consent of owner required to trap on improved, inclosed land of another. Traps must be visited at least once in 24 hours. Animals may be removed from traps on Sunday, but traps may not be set or reset on such day.

Possession and sale: No restrictions on skins legally taken during open season.

Shipment and export: No restrictions on skins legally taken during open season.

Miscellaneous: Introduction of fox or raccoon in Dukes County prohibited. Unlawful to import any live wild fur animals except under permit.

Propagation: May be permitted under regulations of division of fisheries and game.

Bounties: Wildcat or lynx, $10; paid by town, but refunded by county.

MICHIGAN

Open seasons:[40]	*Dates inclusive*
Beaver in Alpena, Montmorency, Otsego, Antrim, Charlevoix, Cheboygan, Presque Isle, Emmet, Chippewa, Mackinac, Luce, Schoolcraft, Alger, Delta, Menominee, Dickinson Marquette, Iron, and Gogebic Counties only	Dec. 5–Dec. 20[40]
Muskrat, mink:[41]	
In Upper Peninsula	Nov. 1–Nov. 30
In Lower Peninsula, north of township 16 north, and west of Saginaw Bay	Nov. 15–Dec. 15
In rest of Lower Peninsula	Dec. 1–Dec. 31
Otter, fisher, marten	No open season.
Raccoon,[41] in Upper Peninsula	No open season.
In Lower Peninsula, north of township 16 north, and west of Saginaw Bay (trapping)	Nov. 1–Nov. 30
In rest of Lower Peninsula	Dec. 1–Dec. 15
Opossum	Nov. 1–Dec. 15
Bear	Nov. 15–Nov. 30
Badger (south of north line of twp. 16)	Oct. 15–Jan. 1
In rest of State	Oct. 15–Jan. 31
Fox, skunk, wolf, coyote, lynx, bobcat, weasel	No close season.

Prohibited methods: Traps must have metal tag showing name and address of owner. Unlawful to trap bears or to use firearms, poisons, spears, baited hooks, explosives, chemicals, mechanical devices, or smokers to drive animals from their holes or homes; or to destroy, disturb, or molest any beaver, raccoon, or muskrat house, hole, or den. Unlawful to set trap within 6 feet of muskrat house or within 500 feet of beaver lodge or home.

Bag limits: One bear a season.

Licenses: Resident, $1.75, nonresident, $10; issued by county clerk. Special license for muskrats (issued to residents only), $2 (authorizes 20 traps; 10 cents for each additional trap, not exceeding 100); issued by director of conservation. Big-game license required to take bears: Nonresident, $50; resident $3.50. Resident citizens and their minor children residing at home may hunt or trap without a license during open season on own inclosed lands upon which they live. License (fee $1.75) to hunt or trap on other lands issued to minor over 12 and under 17 on application of parent or guardian, but such licensed minor while hunting or trapping must be accompanied by parent or guardian. Dealer: Resident, $10; nonresident, $50. Dealers must make monthly reports. Tanning or dressing furs, $5. Alien prohibited from hunting or taking any wild animals in State.

Special county beaver-trapping license, $10 (authorizes trapping of 15 beavers in area opened by director, but not more than 4 from any one colony); license accompanied by seals for tagging skins.

Possession and sale: Possession of carcass or skin of fur animal killed in close season prohibited. Possession of bear permitted during open season and 60 days thereafter. Skins in possession 5 days after close of open season must be reported to conservation department. Persons selling skins of fur animals must report name and address of person to whom sold, and number and kind of skins sold.

Shipment and export: Export of bear prohibited except by nonresident licensee. Skins of bears may be exported under permit. Dealers must have permit from director to export furs. Packages must be labeled with names and addresses of consignor and consignee, and contents.

Propagation: Annual license required to engage in raising fur animals; fees, $5 to $50, depending on number of animals, or acreage. Live animals and skins of animals raised in captivity must be tagged (fee, 5 cents for each tag).

Bounties: None paid.

MINNESOTA

Open seasons:[42]	*Dates inclusive*
Bear, in even years	Nov. 15–Nov. 25.
In odd years	Apr. 15–May 15.
Skunk	Oct. 20–May 1.
Raccoon	Nov. 1–Dec. 1.
Beaver, otter, fisher, marten	No open season.
Muskrat	([43]).
Mink, weasel, wolf, wildcat, lynx, fox	No close season.

Prohibited methods: Use of poison prohibited, except as permitted by commissioner. Unlawful to molest or destroy muskrat or beaver house, den, dam, or abiding place; to hunt these animals with dogs; or to take muskrats in any manner except by trapping, but muskrat houses must not be destroyed in placing traps therein, and not more than 50 traps for muskrats may be operated at one time by one person. Unlawful to dig out or take red-fox cubs from dens, or stake or set traps during close season. Traps may not be set under ice near a muskrat house or in runways or channels used by muskrats, nor may traps for minks be placed in muskrat houses. Muskrat traps may not be set between 8 p. m. and 6 a. m. Bears may not be taken by use of steel traps, except under permit of commissioner. Dogs may not be used for hunting racoons in territory inhabited by deer.

Licenses: Trapping, issued to residents only: Fee, $1; by county auditors and authorized agents; commissioner may issue license (fee, $1; bond, $500) to trap a specified number of beavers at a designated time and place; licensee must report the taking of beaver within 15 days and obtain tag from commissioner, fee, $2.50. Licensed trapper required to make report within 30 days after his license expires, showing number of each kind of fur animal taken thereunder. Owners, lessees, or members of their immediate families may trap fur animals except beaver without license during open season on own or leased land occupied by them as a permanent residence. Unlawful to enter growing grain for purpose of killing any wild animal without permission of owner. Buyer: Resident, local, $1; traveling $10; nonresident, $25; wholesale, $1. Applicant for fur-buyer's license must furnish $1,000 bond. Buyers must make reports.

---

[40] *Michigan:* Season on beaver closed until opened by conservation commission. Under this authority the season has been opened in 1931 in counties above indicated. Under permit from conservation director fur animals, except beaver, may be destroyed on one's own premises to protect property, but hides must be disposed of as required by conservation director. Beavers doing damage may be taken under permit of conservation director, but animals so taken shall be used only for propagation on licensed preserves. Unlawful to trap on State game preserves or to trap badgers in and within 2 miles of any city public park containing more than 200 acres, of which 150 acres or more is woodland.

[41] Mink may be hunted at any time; and, in Lower Peninsula, raccoon may be hunted Nov. 1–Nov. 15.

[42] *Minnesota:* Wild animals including beavers causing injury to property may be taken at any time under permit of commissioner, who may also issue permits to take unprotected animals on game refuges.

[43] Muskrat season fixed by executive order not to exceed 30-day period between Mar. 1 and Apr. 30; communicate with Game and Fish Commissioner, St. Paul.

Possession and sale: Skins of beaver legally taken, when tagged (fee, $2.50), and skins of other fur animals legally taken if tagged within 5 days after close of season, may be possessed, bought, or sold at any time. Possession in close season without tags prohibited.

Shipment and export: Skins of beaver legally taken, when tagged (fee, $2.50) and other skins legally taken may be transported at any time. Export of red-fox cubs taken in State prohibited. Package or receptacle containing wild animals or parts thereof when transported by a common carrier must have attached a proper coupon tag bearing signature, address, and license number, of shipper, together with number and kind of animals or parts thereof contained therein, or if shipped by owner or occupant of land a signed statement that "The contents of this package were taken from animals killed on my land."

Propagation: Annual license (fee, $3 for 10 acres or less, 15 cents an acre for additional lands) from commissioner of game and fish required to operate a fur farm. Muskrat or beaver farm must be inclosed with animal-proof fence. Beavers or muskrats on area at time of inclosure must be purchased from commissioner by licensee at $10 each for beavers and 50 cents each for muskrats. Pelts of animals from fur farms must be tagged (fee, 1 cent each) before being sold or transported. Fox and mink may not be sold for propagation unless penbred for two successive generations. Trespassing on licensed fur farm prohibited. Licensee must make annual report.

Bounties: Wolf, $15; cub wolf, $6; paid by State; county or town boards, may offer bounty on wolf, gopher, ground squirrel, groundhog, rattlesnake, crow, or blackbird.

MISSISSIPPI

Open seasons:	*Dates inclusive*
Otter, mink, muskrat, skunk, raccoon, opossum, fox, weasel (trapping)	Dec. 1–Jan. 31.[44]
Beaver, bear	No open season.
Wildcat	No close season.

Prohibited methods: Unlawful to remove a fox from the ground or a tree in any manner, or needlessly to destroy beaver houses or dams. Fur animals protected when driven from their natural habitat by high water or fire. Trapping devices must be inspected and contents removed every 36 hours.

Licenses: Nonresident, not permitted to trap fur animals; resident, $10 (county); issued by sheriff. License not required to trap or hunt fur animals during open season on land owned or leased by resident. Written permission required to trap on posted land of another.

Possession and sale: No restrictions on skins legally taken during open season and first 5 days of close season. Fur dealer required to keep record of skins purchased, with name, address, and license number of trapper.

Shipment and export: Shipment or export of green hides of fur animals prohibited except during the open season and 5 days thereafter.

Propagation: Muskrats raised on licensed preserve for commercial purposes may be trapped thereon by proprietor December 1 to February 28. Fur animals raised on licensed preserve may be bought or sold and shipped within or out of State for propagation.

Bounties: None paid.

MISSOURI

Open seasons:[45]	*Dates inclusive*
Beaver	No open season.
Wolf, coyote, wildcat	No close season.
Other fur animals	Nov. 15–Jan. 15.

Prohibited methods: Use of poison or smoke device in taking any protected animal prohibited. Unlawful to injure or destroy beaver dams or houses.

Licenses: Hunting license required to trap: Resident, State, $2.50; county, $1 (good in county of residence or adjoining county); issued by county clerk or license collector. Nonresident or alien, $10. Fur dealer and shipper, $5. Taxidermist, $1. Issued by commissioner. Written permission required to trap on inclosed premises of another.

Possession and sale: Possession and sale of green pelts prohibited during close season, but dry pelts may be possessed and sold during open season and 10 days thereafter.

Shipment and export: Shipper must show hunting or dealer's license to transportation company or carrier. Furs taken out of season may not be possessed for any purpose. Undried or "green" pelts may be shipped only during open season, but pelts of wolves, coyotes, and wildcats may be shipped at any time and in any condition. Dried pelts may be shipped during open season and 10 days thereafter. Shipments must be marked with name and address of shipper, his license number, date of shipment, and nature of contents.

Propagation: Permits to capture fur animals for propagating purposes may be obtained from State game and fish commissioner, fee, $5; breeder's permit, fee, $5.

Bounties: Hawks, eagles, horn owls, 50 cents each; paid by State on requisition of county clerk.

MONTANA

Open seasons:[46]	*Dates inclusive*
Fisher, muskrat,[47] mink, fox	Dec. 1–Apr. 15.
Beaver,[48] marten or sable, otter, raccoon	No open season.[49]
Other fur and predatory animals	No close season.

Prohibited methods: Unlawful to capture or kill any fur animal from automobile, from a public highway, or by aid or use of set-gun, jack or other artificial light, or dog. Beaver and muskrat houses protected from injury.

Licenses: Trapping license, $10 (issued only to holder of $2 resident general hunting license); special permit (fee, $10) required to trap beavers on own land when doing damage or to export their skins; skins of beavers so taken must be forwarded to commission for tagging (fee, 50 cents each); issued by State game warden. Fur dealer: Resident, $1; nonresident, $25; agent, $10; taxidermist, $15.

---

[44] *Mississippi:* Mink, skunk, opossum, fox, and weasel when doing damage may be trapped at any time by owners or tenants on own holdings or by officers of the law. Opossum may be hunted Oct. 1–Jan. 31, and raccoon may be hunted Nov. 15–Jan. 31. Foxes may be chased and killed with hounds Sept. 1 to Mar. 1.

[45] *Missouri:* Fur animals may be destroyed at any time and in any way by person residing on own land to protect premises from depredations, but pelts of animals so killed may not be sold or shipped out of season.

[46] *Montana:* Commission may create fur-bearing animal districts and restrict or prohibit trapping therein.

[47] Muskrats doing damage may be taken under permit of commission, except that permit is not required from June 1 to Aug. 31.

[48] Unlawful to kill beavers except when doing damage to own land, and then only under a special permit from State game warden (fee, $10), for which application must be filed between May 1 and Nov. 30. Permits expire May 1, and skins must be reported and tagged by July 1. All skins of animals so taken must be properly cured and forwarded to State game warden, Helena, to be tagged with a numbered metal tag (fee, 50 cents for each tag). Tagged skins may be sold or shipped within State, but a shipping permit (fee, 50 cents) must be attached to each shipment sent out of State.

[49] Commission may open season on otter, raccoon, and marten or sable.

Possession and sale: Sale and shipment of beaver skins, whether taken within or coming from without State, prohibited, except that skins legally taken under permit and tagged may be shipped or sold within State or they may be exported under shipping permit from State game warden. Beaver skins coming from without State must be reported to State warden within 3 days after arrival in State with affidavit showing number of skins, date of receipt, name and address of person from whom received, tag numbers, and method of transportation. They may then be bought and sold, or exported under shipping permit (fee, 50 cents). No other restrictions on skins legally taken.

Shipment and export: (See Possession and sale and footnote 48.) No restrictions on skins legally taken, possessed, or tagged. Permit required to ship out furs; packages must be marked to show contents. Package containing beaver skins offered for transportation must be marked to show names and addresses of consignor and consignee, number of skins, and number of shipping permit.

Propagation: Fur-farm license, $5. Permit for sale of live beavers trapped in State, $3 each animal; sale restricted to holders of fur-farm licenses.

Bounties: Mountain lion, $20; adult wolf, $15, pup, $2; coyote, $2. Paid from State bounty fund on animals killed between April 1 and July 1, inclusive.

NEBRASKA

Open seasons:[50]	*Dates inclusive*
Beaver[51]	No open season.
Muskrat, east of and including Knox, Antelope, Boone, Greeley, Valley, Custer, Dawson, Gosper, and Furnas Counties	Dec. 1–Mar. 1.[50]
In rest of State	Jan. 1–Apr. 1.[50]
Raccoon, opossum, otter	Nov. 16–Feb. 15.
Fox	Nov. 1–Feb. 15.
Other fur animals	No close season.

Prohibited methods: Unlawful to use spear or like device in hunting or taking fur animals, or explosives, chemicals, mechanical devices, or smokers of any kind, or ferrets to drive fur animals from holes, dens, or houses. Unlawful to disturb or destroy den or house of fur animal except of muskrat obstructing a public or private ditch or watercourse; unlawful to cut down or into any tree containing a den. Unlawful to trap on lands of another without consent of owner.

Bag limits: Three each of raccoons and opossums a day or in possession.

Licenses: Resident, $2.10; nonresident or alien, $100 (required for 1,000 or less fur animals; $5 additional for each 100 or less additional animals); buyers, $1; raw fur dealer, $10; issued by Game, Forestation, and Parks Commission and authorized vendors.

Possession and sale: Possession of green hides prohibited, except during open season and 10 days thereafter. Permit may be procured from commission for possession for longer period. Beaver skins coming from without State, upon being inspected and stamped by State warden, may be possessed and sold at any time. No other restrictions on skins legally taken.

Shipment and export: Green hides may be transported by express, baggage, or mail during open season and 10 days thereafter, if package is labeled (in two places) with name of consignor, number of his trapping license, and number and kind of hides. No other restrictions on skins legally taken.

Propagation: Fur animals raised in captivity under fur farmer's license (fees, $1 to $10, depending on number of animals) may be sold alive and transported for breeding purposes, and skins, when tagged and labeled with name of licensee, number of license, and kind and number of skins may be sold and transported at any time.

Bounties: Wolf, coyote, mountain lion, $2 each, and wildcat, $1, Apr. 1 to Oct. 1; ground squirrel, pocket gopher, crow, magpie, 10 cents each, jack rabbit, 5 cents. Paid by county.

NEVADA

Open seasons:	*Dates inclusive*
Muskrat, raccoon, marten, fisher, fox (silver and red)	Nov. 15–Mar. 15.[52]
Bear, wildcat, bobcat, lynx, wolf, wolverene, coyote, weasel, otter, badger, mink, skunk	No close season.
Beaver[53]	Jan. 1, 1934.

Prohibited methods: Unlawful to take fur animals in any manner except by trap or gun, or to molest or destroy any muskrat nest.

Licenses: Hunting license required: Resident citizen, $2.50; nonresident citizen, $10. Issued by county clerk, State fish and game warden, or his deputies. License not required of minors under 14, nor of persons trapping on own land. Special county license for muskrat: Resident of State, $2.50; nonresident of State, $10. Good only in county of issue.

Possession and sale: Unlawful to possess beaver or other skins unless it can be shown that they were legally taken. No other restrictions.

Shipment and export: No restrictions on skins legally taken.

Propagation: Game or fur animals (except beaver and otter) raised in a licensed preserve (fee, $25) may be sold or shipped at any time under invoice.

Bounties: Mountain lion, $5; paid by county. Counties pay bounty of 1½ cents each for pocket gophers when at least 100 heads are presented at one time.

State board of livestock commissioners is authorized to pay bounty from funds derived from tax on horses, cattle, and hogs. The reward for coyote, coyote pup, wildcat, or lynx is 75 cents each; for mountain lion, $5.

State board of sheep commissioners is authorized to pay bounty from funds derived from tax on sheep, payments being same as those made by board of livestock commissioners.

NEW HAMPSHIRE

Open seasons:[54]	*Dates inclusive*
Marten or sable, otter, fisher, mink, muskrat, skunk, fox[55] (see exception)	Nov. 1–Feb. 29.
Exception: In Carroll, Coos, and Grafton Counties	Oct. 20–Feb. 29.
Raccoon (see exception)	Nov. 1–Dec. 31.[55]
Exception: In Carroll, Coos, and Grafton Counties	Oct. 20–Dec. 31.
Beaver	No open season.
Other fur animals	No close season.

Prohibited methods: Bear traps must be safeguarded in a substantial manner. Use of poison or set guns or snares is prohibited. Unlawful to destroy house, den, or burrow of any fur animal or to set a trap in or at entrance of a muskrat house.

Licenses: Resident, $5.15; nonresident, $25.15; issued by commissioner or agents. Resident fur dealer: $25 (State); one or more counties, each county, $3; issued by fish and game commissioner. Fur dealers must keep records and furnish copy to commissioner during January of each year. Persons selling or shipping furs outside State other than through resident buyer must keep same records and make same reports as fur dealers. License not required of resident landowners and their minor children to trap on own farm lands during open season, nor of minors under 16 when accompanied by parent or guardian holding license. No person may trap on lands of which he is not owner or lessee without written permission of owner. All metal traps must be legibly marked or stamped with trapper's name, and must be visited at least once every 24 hours. Unlawful to take traps of another or to remove fur animals from them. Trappers are liable for any damage to domestic animals by traps.

---

[50] *Nebraska:* Fur animals, except beavers, may be taken at any time for the protection of property, but permit must be obtained to destroy muskrats.

[51] Beavers damaging or destroying property may be trapped or otherwise removed by commission, or owner may do so under permit. Pelts of beavers so killed shall be the property of permittee, who is required to report the number of animals killed.

[52] *Nevada:* Boards of county commissioners may change season on muskrats.

[53] Beavers doing damage to property may be trapped under authorization from board of fish and game commissioners. Furs of animals so taken must be preserved and turned over to board for sale, half of proceeds to be returned to trapper. Other fur animals injuring property may be killed in any manner at any time.

[54] *New Hampshire:* Fur or predatory animals may be killed at any time when destroying domestic animals or fowls.

[55] Raccoons and foxes may also be taken by use of dog and gun during October.

Bag limit: 20 raccoons a season.

Possession and sale: Possession of fur animals permitted only during open season, but skins legally taken may be bought or sold at any time. Nonresident dealers may purchase furs from licensed resident dealers.

Shipment and export: No restrictions on skins legally taken and possessed.

Miscellaneous: Unlawful to tear down or destroy any fence or wall, leave open any gate or bar, or trample or destroy any crop on land of another while trapping or pursuing wild animals.

Propagation: Permit (fee, $2) required to propagate fur animals, game, or fish.

Bounties: Bear, $5; bobcat or lynx, $20; paid by fish and game department; hedgehog, 20 cents, paid from general fund.

NEW JERSEY

Open seasons:	*Dates inclusive*
Skunk, mink, muskrat,[56] otter	Nov. 15–Mar. 15.
Raccoon	Oct. 1–Dec. 15.
Beaver	No open season.
Other fur animals	No close season.[57]

Prohibited methods: Muskrat, skunk, mink, and otter may be taken by trap only. Unlawful at any time to disturb the lodge or nesting chamber of a muskrat. Raccoons may not be trapped, but may be hunted with dogs and firearms, without permit, from sunset to sunrise in season.

Licenses: Hunting and fishing license required to trap: Nonresident and alien, $10.50; resident, $1.65. Issued by county, city, or town clerk, salaried wardens, or registrars of licenses. Alien required to own real estate to value $2,000 above encumbrance to obtain license. Licensee must wear license button. Resident minors under 14 may trap without license. Occupant and immediate members of his family residing on farm may trap thereon without license during open season. Nonresident fur dealer or agent, fee $50; license issued by fish and game commissioners.

Possession and sale: Possession of raccoons permitted during open season and 10 days thereafter, except they may be possessed at any time under a breeder's license, but skins legally taken may be possessed and sold at any time. Possession of live fox prohibited except by permission of board of fish and game commissioners.

Shipment and export: Export of raccoons prohibited, except by nonresident licensee, or holder of breeder's license, but pelts of raccoons legally taken may be exported at any time. No other restrictions on skins legally taken or possessed.

Miscellaneous: Unlawful to molest trap set by another or to take animal caught in such trap. Unlawful to liberate fox in State.

Propagation: Raccoons may be raised or kept in captivity under breeder's license (fee, $5); no other restrictions except those imposed by close seasons, during which fur animals may not be taken for breeding purposes.

Bounties: Fox, $3; woodchuck, amount not exceeding 50 cents, fixed by boards of chosen freeholders; paid by counties.

NEW MEXICO

Open seasons:	*Dates inclusive*
Beaver	No open season.[58]
Bear	Oct. 1–Oct. 31.[58]
All other fur animals	No close season.

Prohibited methods: No restrictions.

Bag limits: One bear a season.

Licenses: Big-game license required to take bears. Nonresident: General, $35.25, game, $30.25, big game, $25.25. Resident: General, $5, game, $4.50; big game, $3. Issued by county clerks and deputy wardens. Alien resident of State or an adjoining State not permitted to hunt or to own or possess shotgun or rifle in State. Licensee must report animals taken in preceding license year.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: Export permit for bear required (fee, $1.25). No restrictions on skins legally taken.

Propagation: Permit from State game warden required.

Bounties: None paid by State.

NEW YORK

Open seasons:	*Dates inclusive*
Bear	Oct. 26–Nov. 15.
Mink, sable	Nov. 10–Mar. 15.
Skunk	Nov. 10–Feb. 10.[59]
Muskrat (see exception)	Dec. 1–Mar. 31.
Exception: In Clinton, Essex, Franklin, Hamilton, Jefferson, Lewis, St. Lawrence, Warren, Washington, and that portion of Herkimer County north of the towns of Ohio and Russia	Dec. 1–Apr. 20.
Raccoon	Nov. 10–Feb. 10.
Beaver	No open season.[60]
Otter, fisher, fox	No close season.

Prohibited methods: Use of chemicals, gas, or other poisonous substances prohibited. Skunks may not be taken by aid of dogs or by digging out or driving them from dens or holes by smoking. Unlawful to kill muskrats by shooting, except they may be taken with a 0.22-caliber rifle in the counties bordering upon Lake Champlain; to take them in box, wire, or cage traps; or to molest, injure, or disturb muskrat houses or dens. Raccoons may not be taken from dens or houses, or by cutting den trees. All traps must be stamped legibly with owner's name, and, except in the Adirondack Park, must be inspected at least once in each 24 hours. Traps used for taking fur animals protected by law may not be staked or set during close season, and no traps of the leg-gripping type, with teeth, or of greater spread than 6 inches, may be used, nor shall traps be so set that an animal will be suspended alive.

Bag limits: One bear a season.

Licenses: Resident, $2.25; nonresident, $10.50; issued by county, city, town, or certain village clerks, inspectors, game protectors. Owners or lessees and members of immediate families who are citizens and residents of State, actually occupying cultivated farm lands, may trap fur animals thereon without license during open season. Minors under 16 may trap fur animals without a license. Indian resident or member of Six Nations residing on reservation wholly or partly within State, fee, $2.25. Only licensed Indians residing on a reservation may take fur animals thereon. Alien not permitted to hunt or kill wild animals except under special license from the conservation department, or to own or possess shotgun or rifle.

---

[56] *New Jersey:* Muskrats may be killed at any time by owner of canal or dam which they are destroying.

[57] Foxes may be hunted with hounds and firearms in daylight from Nov. 10 to Apr. 30, except during open season for deer (Dec. 17 to 21). Killing of fox must be reported to commission or county warden within 48 hours.

[58] *New Mexico:* When destroying property beavers and bears may be killed under permit from State game and fish warden. Skins of beavers so taken must be turned over to State warden for disposition.

[59] *New York:* If injuring property, skunks may be taken at any time and in any manner, but the skins of animals so taken shall not be possessed, sold, bought, or trafficked in.

[60] In sections of State designated by conservation department beavers may be trapped from Mar. 1 to Mar. 31.

Possession and sale: Fur animals may be possessed during open season only, but hides of fur animals legally taken and possessed may be bought or sold at any time.

Shipment and export: Shipment and export prohibited, except hides of fur animals legally taken and possessed may be transported at any time.

Propagation: Protected fur animals may be kept alive in captivity for propagation and sale, under license from the conservation department (fee, $5). No fur-bearing animals may be kept that are taken wild during close season for such animals (unless taken under license); nor may they be disposed of during close season except for propagation. The conservation department is authorized to issue license to capture animals for propagation: Fee for permit, $1. License to breed, sell, or possess ferrets, fee, $1.

Bounties: None paid.

NORTH CAROLINA

Open seasons:[61]	*Dates inclusive*
Bear	Oct. 1–Jan. 15.
Beaver	No open season.
Mink, muskrat, otter, raccoon, opossum	Nov. 15–Feb. 15.[62]
Fox[63] (see exception)	No open season.
Exception: In Ashe, Avery, Iredell, Lenoir, and Watauga Counties	No close season.
Wildcat, skunk	No close season.

Prohibited methods: Unlawful to set steel trap for bear. Use of poison or artificial light prohibited. Unlawful to cut down den trees of fur animals.

Licenses: Resident: Trapping, $3.25 (State); $2.25 (county). Nonresident: Trapping, $25.25. Board of conservation and development may issue combination hunting and trapping license at a cost less than total of hunting and trapping licenses purchased separately. Nonresident owning land in State may obtain license to trap thereon (fee, $5.25). Issued by clerks of superior courts, wardens, and deputies. Resident landowners and dependents under 21, and lessees, may trap on own or leased lands without license. Minor under 16 resident of State may trap under license of parent or guardian, and nonresident minor child of resident may obtain resident license when visiting parent. Raw-fur buyers or dealers: Resident, state-wide license, $75; county, $10, and $10 for each additional county. Nonresident, state-wide, $400, and $50 in addition to be collected by each county in which he conducts business. Members and employees of a resident person, firm, or corporation required to purchase duplicate license (fee, $10) showing their employment. A $1 license entitles dealer to purchase not to exceed $500 worth of furs in county of residence only. Dealers and buyers must make annual reports.

Possession and sale: Skins of fur animals lawfully taken may be bought, sold, and possessed at any time.

Shipment and export: No restriction on skins lawfully taken.

Propagation: Fur animals may be taken for propagation under permit (fee, $1) of State game warden.

Bounties: Wildcat, $2; hawk, 25 cents; crow, 15 cents, each, Nov. 20 to Feb. 15. Paid by department of conservation and development through county game wardens.

NORTH DAKOTA

Open seasons:[64]	*Dates inclusive*
Mink, weasel, raccoon, fox	Nov. 15–Feb. 15.
Muskrat	Dec. 15–Feb. 15.
Skunk, badger	Nov. 1–Feb. 28.
Beaver	No open season.[65]
Other fur animals	No close season.

Prohibited methods: Unlawful to cut into, molest, destroy, or dynamite any beaver dam or beaver or muskrat house or mound; or to shoot or spear muskrats; or to flood the burrow or retreat of badgers.

Licenses: Resident, $2; nonresident, $25; issued by commissioner, deputies, and county auditors. License not required of person under 16 or of resident or members of family residing permanently with him to trap on own cultivated land during open season, except for beaver. Fur dealers: Nonresident buyer or shipper or agent, $25; resident shipper or buyer, $5 for each place of business in State; resident traveling agent, buyer, or shipper, $15; issued by game and fish commissioner. Fur dealer must render annual report. Unlawful to trap muskrats on posted lands of another. Aliens prohibited from hunting, taking, or killing any wild animal, except in defense of person or property.

Possession and sale: Skins of fur animals legally killed may be possessed or sold during open season and first 10 days of close season. Possession and sale during close season allowed under permit.

Shipment and export: No restrictions, except as to beaver, on pelts legally taken.

Propagation: State game and fish board issues permits (fee, $5) to breed and domesticate fur animals, and also permits to sell or ship them when raised in captivity. Under permit from board and $500 bond such fur animals may be taken at any time for breeding purposes. Annual reports are required of licensed breeders.

Bounties: Adult wolf or coyote, $3; pups, $1.50 each.

OHIO

Open seasons:[66]	*Dates inclusive*
Raccoon,[67] skunk, opossum	Nov. 15–Feb. 1.
Fox	Nov. 15–Jan. 1.
Mink	Nov. 15–Mar. 1.
Muskrat, in Lake Erie trapping district	Dec. 1–Mar. 15.[68]
In inland trapping district	Nov. 15–Mar. 1.[68]

Prohibited methods: Unlawful to dig out or destroy the house, den, or burrow of fur animals or to smoke or drown the animals therefrom. Unlawful to spear muskrats, or to take raccoons from dens.

Licenses: Resident citizen, $1.25; nonresident citizen, $15.25; issued by county and township clerks and clerks of common pleas courts. License not required of owners, managers, tenants, or their children to trap during open season on own land. Written permission from owners or authorized agents required to trap on lands of another.

---

[61] *North Carolina:* Board of conservation and development may make regulations governing use of steel traps in taking fur animals, and may prohibit their use in any county or district upon petition and hearing. Animals committing depredations may be taken at any time.

[62] Raccoon and opossum may be taken with dogs and gun only. Oct. 1–Feb. 15.

[63] Foxes are classed as game animals, but no season is fixed under State law. County laws governing the hunting or taking of foxes are enforced by State.

[64] *North Dakota:* Fur animals, except beavers, may be killed at any time to protect one's own property, but pelts of such animals may not be commercialized in except during open season.

[65] When beavers in any locality have become so numerous that, in the judgment of the game and fish commissioner, a limited number may be taken without unduly depleting the species, or when they cause substantial damage to public or private property, the commissioner may issue to any landowner or his agent a license (fee, $3) authorizing the taking of a specified number. Licensee must report within 10 days the number of animals taken, and must procure from commissioner a tag (fee, $1 each) for each animal or pelt taken. Tagged animals or pelts may be bought, sold, possessed, or transported at any time under regulations of the commissioner.

[66] *Ohio:* Protected fur animals, when damaging property, may be destroyed by owners or tenants of land (except on Sunday). Skins may not be removed from animals so killed.

[67] Raccoons may not be taken except from 6 p. m. to 6 a. m. and at field trials.

[68] Lake Erie trapping district includes Lake Erie and water, lands, and marshes adjacent to or within 10 miles thereof; inland district includes rest of State.

Possession and sale: Possession of fur animals during close season prohibited, but skins legally taken may be be possessed or sold at any time. Raccoons legally taken may be possessed alive in inclosures as pets.

Shipment and export: Shipment and export prohibited, except that skins legally taken may be transported at any time. Packages containing fur animals or parts thereof when transported by common carrier must be marked to show contents, initial point of billing, and names and addresses of consignor and consignee.

Propagation: No restrictions, except those that prevent capture of wild stock in close season.

Bounties: Townships pay a bounty of $1 each on certain hawks and the great horned owl, and 25 cents on crows.

OKLAHOMA

Open seasons:[69]	*Dates inclusive*
Beaver, otter, fox,[70] marten or sable	No open season.
Raccoon, mink, opossum, skunk, muskrat, civet cat, badger	Dec. 1–Jan. 31.[71]

Prohibited methods: Use of traps (other than smooth-jawed single-spring steel trap having spread of not more than 4 inches), snare, deadfall, or other device, prohibited. Traps must be visited once in 24 hours. Unlawful to set trap in the open, or in path, road, or runway of domestic animals or dogs.

Licenses: Trapping license issued only to holder of hunting license. Resident citizen, $1.25 (not to exceed 10 traps); professional trapper, $50 (required of resident citizen using more than 10 traps); nonresident, $250. Issued by warden, deputy, or county clerk. Licensed trappers required to report within 30 days after expiration of license all pelts taken, sold, or shipped, with names and addresses of persons to whom disposed of. Trapping license not issued to person under 14, nor to person under 16 without consent of parent or guardian. License not required of resident landowners, tenants, or their children to trap on land owned or occupied by them. Written consent of owner required to trap on occupied lands of another. Fur buyer, $3; wholesale fur buyer, $25; issued by State game warden. All licensed fur buyers required to keep daily records and render monthly reports.

Possession and sale: Unlawful to sell or possess pelts of fur animals except during open season and first 10 days of close season. Pelts of foxes [70] legally killed must be delivered to clerk of school district in which killed, and may be sold by him, proceeds to go to general fund of district.

Shipment and export: No restriction during open season and first 10 days of close season on skins lawfully taken or acquired.

Propagation: State game warden issues permits to propagate fur-bearing animals (fee $2, together with fees for tagging). Licensed breeders may sell and transport animals raised in preserves under rules prescribed by warden.

Bounties: County commissioners are authorized to offer bounty on gray wolves or coyotes ($5), and may also pay bounty of not exceeding 5 cents each on crows, English sparrows, hawks, rabbits, prairie dogs, pocket gophers, and ground squirrels. Chaparral bird (road runner), 25 cents, paid by State.

OREGON

Open seasons:[72]	*Dates inclusive*
Beaver [73] in Clatsop, Columbia, Multnomah, and Marion Counties, and west of a line through town of Scottsburg in Douglas county	No close season.
In rest of State	No open season.
Mink, otter, fisher, marten, muskrat, raccoon, ringtail cat	Dec. 1–Feb. 28
Bear in Jackson, Josephine, and Klamath Counties—no close season elsewhere	Nov. 1–Nov. 30.
Other fur animals	No close season.

Prohibited methods: Unlawful to destroy muskrat house, except where it obstructs ditch or watercourse. Flesh of game animals or birds may not be used as trap bait.

Licenses: Resident trapping, $3; not required for trapping on own premises; issued by State game commission. Nonresident must obtain hunting license (fee, $15). Taxidermist, $5. Fur dealer, $10; fur dealer's agent, $3. Licensee must keep chronological record showing number and kind of furs purchased, and names and address of persons from whom obtained, and make verified annual report to commission. Unlawful for unnaturalized persons to hunt or trap without gun license ($25) and hunting license. Unlawful to remove or disturb traps of a licensed trapper on public domain or on land where he has permission to trap. Licensed trappers are required to make verified annual reports of number of animals caught, receipts for fur, and where sold.

Possession and sale: Fur animals or hides legally taken within or without State may be possessed or sold at any time.

Shipment and export: Shipment and export prohibited, except that skins of animals legally taken may be shipped at any time.

Propagation: Permit (fee, $2) to keep fur-bearing animals may be obtained from State game commission. Hides of animals raised in captivity must be tagged before being sold. Yearly reports to commission required.

Bounties: State game commission is empowered to pay bounties on any predatory animal in order to protect game. In Marion County: Moles and gophers, 10 cents each, gray digger squirrel, 5 cents; paid by county clerk.

PENNSYLVANIA

Open seasons:[74]	*Dates inclusive*
Bear (over 1 year old)	Nov. 1–Dec. 15.[75]
Muskrat	Dec. 1–Feb. 29.
Racoon (see exception)	Oct. 15–Dec. 15.
Exception: In Adams, Bedford, Berks, Bucks, Carbon, Chester, Cumberland, Dauphin, Delaware, Fayette, Franklin, Fulton, Lancaster, Lebanon, Lehigh, Philadelphia, Washington, and York Counties	Nov. 1–Jan. 1.
Skunk, mink, otter, opossum	Nov. 1–Feb. 29.
Fox, wildcat, weasel	No close season.[76]
Beaver	No open season.

Prohibited methods: Unlawful to take bears with steel trap, deadfall, or pen, or to shoot them except with a single bullet, but the use of steel-jacketed bullets is prohibited. Use of automatic firearms prohibited. Steel traps having a spread of jaws greater than 6½ inches may not be used for trapping fur animals or vermin. All traps must bear metal tag showing name and address of owner, must be visited once in every 36 hours, and at end of open season must be taken up or sprung. Unlawful to dig out fur animals; to drive them from holes or dens by use of smoke, explosives, or chemicals; to cut den trees; or to take fur animals by use of poison. Beaver houses and dams are protected, except under special permit. Unlawful to disturb traps of another or to remove fur animals therefrom.

---

[69] *Oklahoma:* Fur-bearing animals may be killed at any time when found actually destroying livestock or poultry.

[70] Foxes are game animals, and may not be killed except when committing depredations. They may be chased with hounds for sport July 1–Feb. 29.

[71] Raccoons may be chased with dogs for sport July 1–Feb. 29.

[72] *Oregon:* Unlawful to hunt or trap fur animals on State game preserve.

[73] Unlawful to trap beavers in national forests. Beavers doing damage may be killed on own or leased property, but such killing must be reported in writing to the commission; beavers so killed are the property of the State, and must be disposed of as commission directs, except that in Clatsop, Columbia, Marion, and Multnomah Counties, and in Douglas County west of a line through Scottsburg they are the property of person killing them; other fur animals damaging property may be killed under permit of State game warden, but skins of animals so taken must be delivered to State game commission for disposition.

[74] *Pennsylvania:* May be shortened or closed by board of game commissioners. Fur animals, except beavers, may be killed or captured alive by landowners or tenants and their employees at any time to protect their growing crops.

[75] Bears may be killed at any time in defense of person or property.

[76] Under permit (no fee) from board, dogs may be used in hunting foxes and wildcats, Dec. 16 to Mar. 15.

Bag limits: One bear a season, or four to a camp or body of men; 3 raccoon a day, 10 a season.

Licenses: Nonresident, $15. Resident, $2. Issued by county treasurer. Minors under 16 may trap fur animals and vermin without a license. Licensee required to wear tag on middle of back. Resident citizen, members of family, and regularly hired help residing on and cultivating land may hunt on such land, and, with consent of owner, on adjoining land without a license, during open season. Alien not permitted to hunt or kill any wild animal in State, except in defense of person or property. Trapper must report to board of game commissioners number of each kind of fur animals killed. Resident fur dealer, buying and selling in State, $5; interstate, $10. Nonresident fur dealer, $50.

Possession and sale: Bears may be possessed only during open season and first 30 days of close season. Bear and raccoon skins taken during open season may be possessed or sold at any time. Raw skins may be possessed during the open season and the first 15 days of close season.

Shipment and export: Skins of bears and raccoons legally taken may be shipped or exported at any time. Packages must be plainly marked to show contents, name and address of owner, and county in which taken. Nonresident licensee may take out one bear legally killed. No other restrictions on skins legally taken and possessed.

Propagation: Fur-farming license, fee $1; license required to breed and sell ferrets, $25; to possess a ferret without breeding, $1.

Bounties: Wildcat, $15; gray fox, $4; weasel, $1. Goshawk (killed Nov. 1–May 1), $5. Affidavit on form supplied by game commission must accompany entire unmutilated skin of animal when presenting claim to board of game commissioners at Harrisburg.

RHODE ISLAND

Open seasons:[77]	*Dates inclusive*
Skunk	Nov. 1–Mar. 15.
Raccoon	Oct. 1–Jan. 31.
Muskrat, mink, otter (see exception)	Nov. 1–Jan. 31.
Exception: Muskrat in Bristol and Newport Counties	Dec. 1–Feb. 29.
Other fur animals	No close season.

Prohibited methods: Unlawful to spread poison outside of buildings, or to set wire snares, or to use steel traps with teeth or with spread over 6 inches, or choke traps with greater openings than 6 inches. Traps must be concealed so as not to endanger domestic animals and must be visited at least once every 24 hours.

Licenses: Hunting license required for trapping; Resident, $2.25; nonresident, $10.25; alien, $15.25; issued by town and city clerks. License not required of resident or his immediate family to hunt or trap on agricultural lands on which actually domiciled; nonresident owning real estate valued at not less than $500, and nonresident member of club incorporated for hunting or fishing purposes prior to January 1, 1909, which owns real estate assessed for taxation at value of not less than $1,000, may procure license at a fee of $2.25; nonresident guest of incorporated fox hunting club, $2.25 (authorizes fox hunting and is good for 6 days); licenses not issued to minors under 15. Written permission required to trap on inclosed lands of another.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: No legislation.

Bounties: Fox, $5; crow and certain hawks and owls, 25 cents; paid by State.

SOUTH CAROLINA

Open seasons:	*Dates inclusive*
Mink, muskrat, otter, skunk, and other fur animals (trapping) (see exception)	Nov. 26–Mar. 1.[78]
Exception: In Hampton County (all fur animals except foxes)	Nov. 1–Feb. 1.
Raccoon,[79] opossum, fox[80] (hunting)	Sept. 1–Mar. 1.
Bear	No close season.

Prohibited methods: Hunting at night prohibited except for raccoon, opossum, fox, mink, and skunk. Unlawful to shoot or trap foxes, to dig them out of ground, or to push or drag them out of tree or log. Unlawful to set, sell, make, or use steel trap or any like device within State except steel traps may be set within 200 yards of residence, or 25 yards of poultry house for protection of property. Use of deadfall prohibited.

Licenses: Hunting license required: Resident, county license, $1.10; State, $3.10; issued by county game warden and his agents; nonresident, $15.25; issued by county game warden. Fur buyer: Nonresident, $200; resident, $25. No license required of resident owners, tenants, their children, or, under written permission, their employees to hunt during open season on own lands. Consent of owner or manager required to hunt or trap on lands of another.

Possession and sale: No restrictions on skins of fur animals legally taken.

Shipment and export: Skins of fur animals must be tagged by State warden or deputy before being shipped or transported. Tag fees: Otter, red fox, $1; raccoon, gray fox, mink, 25 cents; skunk, 10 cents; opossum, muskrat, 5 cents. Packages containing furs for transportation must bear certificate of State warden or deputy that tag required to be attached to each pelt has been properly attached and paid for. Persons, firms, or corporations shipping furs must make monthly report to county game warden of number of skins shipped or transported. Shipments must be labeled to show number and kind of skins in package and consignor and consignee. No other restrictions on skins of fur animals legally taken.

Propagation: No legislation.

Bounties: None paid.

SOUTH DAKOTA

Open seasons:[81]	*Dates inclusive*
Muskrat[82]	Jan. 15–Mar. 15.
Opossum	Dec. 15–Mar. 1.
Raccoon	Nov. 1–Jan. 31.
Skunk[82]	Nov. 1–Dec. 31.
Beaver,[82] otter, silver, black, or cross fox	No open season.
Other fur animals	No close season.

Prohibited methods: Unlawful to shoot or spear muskrats, or to destroy or molest muskrat houses, except that these may be opened without injury thereto for purpose of placing traps therein during open season. No person may set or operate more than 75 traps at any one time.

Licenses: Resident only, $2; issued by director of game and fish and county treasurer. Fur dealer's license (no fee) issued by director of game and fish. Licenses not required of residents under 14, nor of landowners trapping on own lands during open season. Unlawful to hunt on cultivated or posted lands of another without permission of owner.

---

[77] *Rhode Island:* Landowner may kill muskrat, raccoon, skunk, and mink on own land at any time.

[78] *South Carolina:* Wildcats may be killed without license at any time by officers of the law and by landowners upon their own holdings.

[79] Raccoons may be killed after July 15 by owners of crops that they are destroying.

[80] Trapping of foxes prohibited. Foxes may be hunted or chased with dogs on own or controlled land, Sept. 1–Mar. 1, and foxes doing damage may be shot on own or controlled lands at any time.

[81] *South Dakota:* Trapping season opens and closes at noon.

[82] Raccoon and skunk doing damage around buildings may be killed at any time, and, under permit from director of game and fish, muskrats or beavers damaging irrigation ditches, embankments, or public highways may be taken at any time. Director of game and fish may authorize trapping of beavers on public lands or game preserves.

Possession and sale: Beaver skins must bear metal tag (fee, 50 cents) from director of game and fish and such skins lawfully possessed may be sold and shipped under permit. Raw furs may be possessed during open season and first 10 days of close season.

Shipment and export: Permit from director of game and fish required to sell or ship beaver skins; unlawful to ship raw skins of protected fur animals during close season, whether taken or killed within or without State.

Propagation: Breeder's permit required to conduct a fur farm; fees, $1 for each silver, black, or cross fox, and $1 for each other kind of fur animal.

Bounties: Bounties not exceeding amounts specified paid by State on animals killed April 1 to August 31, as follows: Wolf (adult), $25; coyote or prairie wolf over 1 year old, $5; less than 1 year, $3; mountain lion, $10; lynx, bobcat, $3. Not paid on animals raised in captivity or for commercial purposes.

TENNESSEE [63]

Open seasons:	*Dates inclusive.*
Raccoon, mink, muskrat, skunk (see exception)	Nov. 15–Feb. 15.[64]
Exception: In Blount and Johnson Counties	No open season.[64]
Opossum (see exception)	Oct. 15–Jan. 15.
Exception: In Blount and Johnson Counties	No open season.
Other fur animals (see exception)	No open season.[65]
Exception: Fox in Dickson and Houston Counties	No close season.[65]

Prohibited methods: Use of poisons, chemicals, explosives, snares, and deadfalls prohibited. Steel traps must be placed at least 12 inches within entrance to hole, cave, den, or hollow log, and traps must be inspected within 36 hours and captured animals removed.

Licenses: Hunting license required to trap—nonresident, $15; resident, $2; issued by county clerk. License not required in Trousdale County, nor of landowners or tenants and their dependent children trapping on own or occupied lands. Nonresident owning land within State may hunt and trap on such land without license. Raw-fur dealer or buyer, $20; issued by county clerk. Written consent required for trapping on lands of another, and all traps must be stamped with owner's name.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: Prohibited, except the owner or the person who killed or captured fur-bearing animals who has in his possession a hunting license may carry out in personal possession fur animals or skins legally taken or acquired.

Propagation: No legislation as to fur animals.

Bounties: None paid.

TEXAS

Open seasons: [66]	*Dates inclusive.*
Bear (game animal)	Nov. 16–Dec. 31.
Beaver, otter (see exceptions)	No open season.
Exceptions: In Austin, Bastrop, Bell, Bosque, Brazoria, Burleson, Burnet, Chambers, Collin, Colorado, Coryell, Dallas, Delta, Erath, Falls, Fayette, Fort Bend, Franklin, Galveston, Hamilton, Harris, Hopkins, Hunt, Lamar, Lampasas, Lavaca, Limestone, Llano, Matagorda, McLennan, Rains, Red River, Robertson, Rockwall, San Saba, Tarrant, Travis, Waller, Washington, and Wharton Counties	No close season.
Beaver, west of Pecos River	Jan. 1–Jan. 31.
Muskrat (see exceptions)	Nov. 15–Mar. 15.
Exceptions: In Cottle County	Nov. 15–Apr. 1.
In Angelina County	No open season.
Fox (see exceptions)	Dec. 1–Jan. 31.
Exceptions: In Cottle County	Dec. 1–Feb. 15.
In Angelina, Austin, Bosque, Burnet, Brazoria, Burleson, Bastrop, Bell, Caldwell, Collin, Colorado, Chambers, Coryell, Dallas, Delta, Erath, Falls, Franklin, Fayette, Fort Bend, Galveston, Harris, Hunt, Hopkins, Hamilton, Lamar, Lee, Lavaca, Llano, Lampasas, Limestone, Milam, Matagorda, McLennan, Rains, Rockwall, Red River, Robertson, San Saba, Travis, Tarrant, Waller, Wharton, and Williamson Counties	No open season.
Other fur animals (see exceptions)	Dec. 1–Jan. 31.
Exceptions: In Cottle County	Dec. 1–Feb. 15.
In Angelina County	No open season.

Prohibited methods: [66] Beds, nests, and breeding places of muskrats protected, and muskrats may only be taken by trapping except on own land, where they may be taken at any time by any means. Headlight, hunting lamp, or other artificial light prohibited in certain areas. Unlawful to trap muskrats on posted or inclosed lands of another without consent of owner.

Bag limits: One bear a season.

Licenses: Resident, $1.10; nonresident, $25. License not required of minors under 17. Fur dealer: Resident, $5.50; nonresident, $50. Issued by game, fish, and oyster commission, deputies, or county clerks. Consent of owner necessary to trap on inclosed land of another. Fur dealers must make sworn monthly report of skins purchased or shipped out of State.

---

[63] *Tennessee:* Trapping on State property, including lakes, prohibited.

[64] Raccoon, opossum, and skunk may be taken with dogs in Blount County Nov. 15–Feb. 15; in Johnson County Oct. 15–Feb. 1, and in Johnson County landowner, tenant, or farmer may kill or trap fur animals at any time when they are a menace to crops or poultry. Raccoon and opossum may be taken with guns or dogs in Henry County Oct. 1–Feb. 15.

[65] Foxes may be chased with dogs for sport at any time.

[66] *Texas:* Unlawful to use steel trap, deadfall, snare, or any mechanical device other than a gun or pistol in taking fur-bearing animals in Anderson, Angelina, Brazos, Cherokee, Grimes, Hardin, Harris, Harrison, Liberty, Madison, Montgomery, Nacogdoches, Panola, Polk, Rusk, Sabine, San Augustine, San Jacinto, Shelby, Trinity, and Tyler Counties. Only bonafide residents may trap in Wood County.

Possession and sale: Possession of untagged pelts during closed season prohibited, but pelts taken during open season and properly tagged may be held during closed season and sold at any time. No restriction on possession for personal use of skins taken during open season. Trapper is allowed 15 days after close of season for drying pelts taken during open season, and pelts intended for sale must be tagged by trapper within 5 days after close of season. Fur tax, beaver, mink, and raccoon skins, 5 cents each; other skins 1 cent each, such tax to be paid by dealer, or by trapper before being sold or offered for sale. Unlawful to purchase, on land of another, pelts of muskrats taken or trapped on such land, except from the landowner or his agent.

Shipment and export: No restrictions on skins legally taken or obtained and on which tax has been paid. Each pelt in shipment must be tagged. Unlawful to ship in or out of State untagged pelts.

Propagation: Permit (fee, $5) must be obtained from game, fish, and oyster commission to trap, keep, or transport wild animals for propagation.

Bounties: Commissioner's court in Jack, Shackelford, Wise, and Young Counties may pay bounty of not more than $50 for each wolf scalp. On petition of 200 freeholders in Bastrop, Brazos, Erath, Hood, Grimes, Jasper, Lampasas, Limestone, McCulloch, Mills, and San Saba Counties, and 50 freeholders in Sterling County, commissioner's court may pay bounty on wolves, wildcats, and other predatory animals.

UTAH

Open seasons:[87]	*Dates inclusive*
Bear	No close season.
Beaver,[88] otter	No open season.
Mink, muskrat,[89] marten, raccoon	Oct. 15–Dec. 15. Feb. 15–Apr. 1.
Other fur and predatory animals	No close season.

Prohibited methods: Use of silencer on gun and discharge of firearm from automobile or within 50 feet of a public highway prohibited. Unlawful to disturb muskrat houses or dens, or to set traps within 25 feet thereof.

Licenses: Resident citizen, $5. Issued by State fish and game commissioner or deputy, county clerk, or deputy or authorized agent. Not issued to minors under 16. Unlawful to disturb or remove traps of licensed trappers on public domain or on lands where they have permission to trap. Aliens other than homesteaders are not permitted to hunt or trap.

Possession and sale: Skins of fur animals legally taken may be possessed and sold at any time, except that skins of beavers, which may be taken only under permit when doing actual damage to property, must be turned over to the commissioner to be sold by him. Possession of beaver and otter skins prohibited, except by a permit holder, unless tagged by commissioner. Green pelt or carcass of fur animal may not be possessed except during open season and 15 days thereafter.

Shipment and export: Shipment and export of furs legally taken and possessed permitted at any time. (See Possession and sale.) Skins of beavers taken under permit of the commissioner may only be shipped by the permittee to the commissioner for sale. Shipment or export of beaver and otter skins prohibited, unless such skins are tagged by the commissioner.[88]

Miscellaneous: Use of flesh of game animals or birds as trap bait for fur animals prohibited.

Propagation: Permit (no fee) from commissioner required to propagate fur animals, but such animals held under permit may not be killed during close season.

Bounties: Wolf, mountain lion, cougar, $15; bear, $10; coyote, $6; lynx, bobcat, $3.

VERMONT

Open seasons:[90]	*Dates inclusive*
Muskrat (see exceptions)	Nov. 1–Apr. 20.
Exceptions: On shores of Lake Champlain in Rutland County; Poultney River below Carvers Falls, and shores of Lake Memphremagog in Orleans County	Jan. 1–Apr. 30.
Waters and shores of Lake Champlain in Addison and Chittenden Counties; Shelburne Pond and banks and waters of La Platte River in Shelburne; Hinesburg Pond (Lake Iroquois) in Hinesburg; East Creek, Dead Creek, Lemon Fair, Little Otter Creek, Lewis Creek, Leicester River, or their tributaries or Otter Creek in Addison County	Jan. 1–Apr. 20.
Mink (see exceptions), raccoon, fox, otter (see exception), marten, skunk	Nov. 1–Feb. 15.
Exceptions: Mink and otter, on shores of Lake Champlain in Rutland County; Poultney River below Carvers Falls; shores of Lake Memphremagog in Orleans County	Jan. 1–Apr. 30.
Fox, in Franklin County	No open season.
Beaver, fisher cat	No open season.

Prohibited methods: Use of set guns, snares, and poisons prohibited; bear traps must be carefully safeguarded, and visited once in 48 hours. Unlawful to open or destroy a muskrat house or to place a trap therein or at its entrance. Unlawful to take skunks, raccoons, or foxes from holes or dens by cutting, digging, smoking, trapping, or snaring, or use of chemicals or any mechanical device.

Licenses: Resident, $1; nonresident, $50; issued by town clerk. Owners of farm lands and their resident minor children or tenants may take fur animals on own lands during open season without a license. License not required of person under 15 to trap, and not issued to person under 16 without written consent of parents or guardians. Nonresident citizen owning improved real estate appraised at not less than $1,000 upon which he pays taxes may obtain a resident license. Persons trapping on inclosed lands or another must, within 12 hours, inform owner of location and number of traps and must visit traps at least once in 24 hours. Fur dealer: Resident, $2; nonresident, $50.

Possession and sale: Possession of fur animals during close season prohibited, but the fur or skins of animals legally taken may be possessed, bought, or sold at any time.

Shipment and export: Packages containing fur animals or parts thereof delivered to a common carrier for transportation must be tagged to show number and kind of such animals or skins therein, names of consignor and consignee, station from which shipped, and destination. A person required to have a license must also show number of his license on shipping tag. No other restrictions on skins legally taken and possessed.

Propagation: State fish and game commissioner issues special permits for propagating fur and game animals (fee, $2 for each species and expense of tagging). Animals bred on fur farms may be sold and transported alive at all times when bearing identification tags prescribed by commissioner.

---

[87] *Utah:* Commissioner may shorten or close seasons on fur animals, or further restrict number that may be taken where necessary to afford sufficient protection to any species.

[88] When beavers are destroying property, State fish and game commissioner may grant permit to trap them, but hides of animals so taken must be delivered to and sold by commissioner, who shall recompense for trapping in not more than half the proceeds from sales.

[89] Property owners may trap muskrats doing actual damage to dams, ditches, or watercourses in sufficient numbers to insure protection to such property.

[90] *Vermont:* Fur animals may be killed at any time to protect one's own property, but such killing must be reported to commissioner within 84 hours and pelts held for official inspection. Disposition of pelts so taken prohibited except under certificate of commissioner.

Bounties: Towns pay $10 bounty on bay lynx or bobcat and $1 on rattlesnake.

VIRGINIA[91]

Open seasons: [92] [93] [94]	*Dates inclusive.*
Muskrat (see exceptions)	Dec. 15–Mar. 31.
Exceptions: In Amelia, Franklin, Lunenburg, and Nottoway Counties	Sept. 16–Mar. 14.
In Halifax, Botetourt, "high woods" of Isle of Wight, Rockbridge, Lee, Southampton, Albemarle, Amherst, Charlotte, Sussex, and Carroll Counties	No open season.
Raccoon (see exceptions)	Nov. 1–Jan. 31.
Exceptions: In Amelia, Franklin, Lunenburg, and Nottoway Counties	Sept. 16–Mar. 14.
In Halifax, Botetourt, "high woods" of Isle of Wight, Rockbridge, Lee, Southampton, Albemarle, Amherst, Charlotte, Sussex, and Carroll Counties	No open season.
Bear, fisher, fox, mink, oppossum, otter, skunk (see exceptions)	Nov. 15–Jan. 31.[93]
Exceptions: In Amelia, Franklin, Lunenburg, and Nottoway Counties (except fox)	Sept. 16–Mar. 14.[95]
In Halifax (except mink), Botetourt, 'high woods" of Isle of Wight, Rockbridge, Lee, Southampton, Albemarle (except fox), Amherst, Charlotte, Sussex, and Carroll Counties (except box traps for rabbits and water sets for mink and muskrat in Carroll County)	No open season.
Fox, in Albemarle, Culpeper, Grayson, Warren, Rappahannock, Nelson, and Spottsylvania Counties	Nov. 1–Nov. 30.
Fox, in Amelia, Clarke, Franklin, Lunenburg, Nottoway, Fluvanna, King George, Lancaster, Northumberland, Richmond, Westermoreland, Essex, King and Queen, and Washington Counties	No open season.[95]
Fox, in Madison and Orange Counties	Nov. 1–Dec. 31.

Prohibited methods:[94] Unlawful to take muskrats in tidewater sections of State from half an hour after sunset to half an hour before sunrise, except by traps. Traps must be marked with name and address of trapper. Traps must be inspected once in each 24 hours. Unlawful to set steel traps in Southampton County until 1932, except by landowners in protection of property.

Licenses: Combined hunting, fishing, and trapping: Nonresident, $15.50, alien, $15.50 (alien owner of real estate resident for five years, same as resident). Enlisted or commissioned personnel of Army, Navy, or Marines stationed in Virginia may obtain licenses for same fees as residents. Resident: State, $3; county, $1. County license may be exchanged for State license upon payment of difference in cost plus a fee of 25 cents. Canvassing fur buyer: Resident $25 (State), $10 (county) and $5 for each additional county. Nonresident, $75 (county) and $5 for each additional county. Persons buying or selling furs required to report on July 1 or 10 days thereafter total paid for furs during preceding year and the species from which furs were taken, etc. Issued by clerks of circuit and corporation courts. Licensee required to wear button issued with license. License not required of residents to hunt foxes with hounds. Residents, nonresidents, and aliens, and their husbands, wives, or children may hunt on own land during open season without a license. Tenant, under written consent of owner or landlord, may hunt without license during open season on lands on which he resides. Written permission is required to trap or hunt on lands of another, except chasing foxes with hounds where chase begins on other lands, and except uninclosed mountain lands not used for cultivation, except in Alleghany, Bath, Bland, Craig, Giles, and Highland Counties and mountains in western part of Rockingham County.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: License required (fee, $5) to raise foxes and rabbits other than native species for fur.

Bounties: Bobcats or wildcats, $5; sharp-shinned and Cooper's hawks, goshawk, great horned owl, 50 cents each; crow (if killed April 1 to September 30), 15 cents each; paid by boards of supervisors.

WASHINGTON

Open seasons:[96]	
Beaver, otter, fisher, marten	No open season.
Other fur animals (open season fixed by county game commissions).[97]	

Prohibited methods: No steel trap larger than No. 3 may be used unless a notice in English language on large placard is placed above trap. Unlawful to take fur animals with gun larger than 10 gauge, or to disturb or remove traps of licensed trapper. Traps must be marked with the name and address of owner.

Licenses: Resident citizen, $5 (county); fur dealer, $10; issued by county auditor. License not required of landowners and leaseholders or their children trapping on own premises. Not issued to minors under 16. Dealers required to make quarterly reports of transactions. Taxidermist, $5.

Possession and sale: Beaver skins obtained without State, if inspected and tagged or stamped (tag, 10 cents) by supervisor of game and game fish or county game commission, may be possessed or sold at any time. Other furs legally taken or coming from without State may be possessed, sold, and transported at any time.

Shipment and export: Skins of fur animals legally taken and possessed may be shipped at any time.

Propagation: Breeder's license (fee, $20; renewal, $10) required. Breeder's ownership of beaver and muskrat on inclosed area contingent upon payment to county game commission of $25 for each beaver, and $1 for each muskrat found to be on such area by a commission selected as provided by law.

Bounties: Paid by State. Counties are permitted to pay bounties on mountain lion or cougar, lynx or wildcat, coyote, timber wolf; and in the

---

[91] *Virginia:* Commission of game and inland fisheries may, by regulation, restrict or extend the seasons and the manner and means by which fur animals may betaken.

[92] The seasons stated are for trapping only and do not refer to hunting. Information concerning local laws or regulations for the hunting of foxes and other fur animals may be obtained from the Commission of Game and Inland Fisheries, Richmond, Va.

[93] Landowners may trap fur animals on their own lands at any time.

[94] It is unlawful to set steel traps at any time in Rockbridge, Southampton, Lee, Albemarle, Amherst, Charlotte, Sussex, and Carroll Counties except by landowner on own lands. In Rockbridge, Albemarle, Amherst, Charlotte, and Sussex Counties a landowner may issue written permit for trapping on his own land.

[95] Landowner may trap foxes on own land in Amelia, Nottaway, Franklin, and Lunenburg Counties.

[96] *Washington:* Communicate with county game commission at county seat or supervisor of game and game fish, Box 384, Seattle. Fur animals may be trapped by landowners or tenants when destroying crops, domestic animals, or poultry.

[97] County game commission may remove or kill game doing damage to property.

Columbia River district bounties are paid on seal or seal lion and hair seal by food fisheries division.

WEST VIRGINIA

Open seasons:	*Dates inclusive*
Skunk, raccoon, opossum	Nov. 1–Jan. 31.
Red fox, in Brooke, Cabell, Fayette, Harrison, Kanawha, Lewis, Mason, Mingo, Morgan, Pleasants, Putnam, Ritchie, Summers, Taylor, Upshur, Wetzel, Wirt, Wood, and Wyoming Counties	Dec. 2–Jan. 31.
In rest of State	No close season.
Beaver, otter	No open season.[98]
Muskrat	Nov. 1–Feb. 29.
Other fur animals	No close season.

Prohibited methods: Unlawful to set steel or spring bear trap on land of another or on own lands unless inclosed by fence. Unlawful to hunt wild animals, except those that take refuge in trees, with spot or jack light or other artificial light, or to cut down any tree in which animals den or take refuge for purpose of capturing such animals. Unlawful to own or possess ferrets.

Licenses: Hunting license required to take fur animals: Resident, $3 (State), $1 (county of residence and adjoining counties); nonresident, $15; issued by county clerk. Resident landowner, his resident children, or tenants may hunt or trap during open season on own land without a license. License not required of minors under 15. Express permission of owner or tenant required to set or maintain a snare or trap upon land of another. Licensee must wear tag.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: Permit (fee, $1) required for taking fur animals for propagation.

Bounties: Game, fish, and forestry commission may pay bounties on predatory wild animals and county courts of Grant, Greenbrier, Monroe, Pendleton, Pocahontas, Randolph, Harrison, and Webster Counties may pay additional bounty on petition of 100 citizens and voters.

WISCONSIN

Open seasons:	*Dates inclusive*
Beaver,[99] marten, fisher, bear, fox (silver, silver black, black)	No open season.
Otter, mink, (see exception)	Nov. 15–Mar. 1.
Exception; Otter, in Marinette County	No close season.
Muskrat (see exceptions) (open in even, closed in odd, years)	Mar. 1–Apr. 25.[1]
Exceptions; In Brown, Calumet, Fond du Lac, Outagamie, Waushara, Waupaca, and Winnebago Counties	Oct. 25–Apr. 1.[1]
In Buffalo, Trempealeau, Jackson, Wood, Portage, Kewaunee, and all other counties south thereof (open in even, closed in odd, years)	Mar. 1–Apr. 10.[1]
In Fox Lake and Trenton, in Dodge County (annual)	Feb. 1–Apr. 1.
Raccoon	Nov. 1–Dec. 31.
Skunk, in all counties south of the north line of Buffalo, Trempealeau, Jackson, Wood, Portage, Waupaca, Outagamie, Brown, and Kewaunee Counties (see exceptions)	Nov. 1–Jan. 31.
Exception; In Brown County	No close season.
In rest of State	Oct. 15–Jan. 15.
Other fur animals	No close season.

Prohibited methods: Unlawful to take mink or muskrat with aid of spear, gun, or dog; to disturb or molest muskrat houses, beaver houses, or beaver dams, or to molest or disturb raccoon or skunk dens or trees. Unlawful to set trap within 500 feet of beaver house or dam. Unlawful to use poison bait, poison gas, dynamite, or other explosive in taking wild animals.

Licenses: Resident, $1, issued by conservation commission or county clerks. Each trap must be tagged (fee 5 cents). Report required from licensed trapper on or before February 1 of each year. Nonresidents not permitted to trap; alien not permitted to hunt. Written consent of owner or occupant required to trap minks or muskrats on agricultural lands of another.

Possession and sale: Possession of green skins of fur animals permitted only during open season and first 5 days of close season; possession prohibited of skin of mink or muskrat that shows that animal has been shot or speared. No other restrictions on possession and sale of skins legally taken.

Shipment and export: No restriction on skins legally taken. Shipments of furs must be marked to show number and kind of hides, name and address of shipper, and number of his trapping license.

Propagation: Under license and supervision of commissioner, beavers, muskrats, skunks, otters, minks, raccoons, fishers, or martens may be taken and transported for propagation within State. Special licenses required to conduct fur farms. Breeders have same rights in silver, silver-black, and black foxes as domestic animals. Unlawful to trespass on posted fox farm.

Bounties: Wolf cub taken between March 1 and November 1, $10; mature wolf killed at any time, $20; wild cat, lynx, $5; paid by State. County boards may offer bounty on crow, hen hawk, pocket gopher, streaked gopher, groundhog or woodchuck, English sparrow, blackbird, or rattlesnake.

WYOMING

Open seasons:	*Dates inclusive*
Beaver [2]	No open season.
Otter, fisher, marten, mink, fox, raccoon	Nov. 16–May 1.
All other fur animals	No close season.

Prohibited methods: Unlawful to trap bears.

Licenses: Resident citizen, $10; nonresident citizen, $50. License not required of persons under 17, nor for trapping predatory animals. Permit for trapping in State game preserves and national forests (fee, $1) issued by State game and fish commissioner. Employees of Federal Government do not require permit to trap predatory animals. Taxidermist, $10. Fur buyer, $10. For bear: Nonresident, $25, limit, 3 bears; resident, $1; issued by commissioner. Dog license, $1 (required for each dog used in hunting bears or predatory animals in national forests). Permission of owner required to hunt or trap on inclosed lands of another.

Possession and sale: Skins of beavers killed when doing damage to real estate may be possessed when duly tagged by commissioner and affidavit is furnished the commissioner by owner of the real estate showing damage and number of beavers killed, and upon payment of $1.50 for each beaver tag.

---

[98] *West Virginia:* Commission may open season on beavers and otters.

[99] *Wisconsin:* If beavers damage property, they may be captured and removed under permit and direction of State conservation commission; skins of animals that are killed in taking must be delivered to conservation commission. Owners or lessees of dams, under permit of conservation commission, may destroy at any time muskrats to protect such dams or levees, but may not sell, barter, or give away skins of such animals killed during close season.

[1] Muskrat—No open season on Lakes Mayflower, Norrie, and Pike, in Marathon County, in village of Marion in Waupaca County; on Fish or Silver lakes in Waushara County; nor on Horicon Marsh in Dodge County.

[2] *Wyoming:* If beavers damage real estate, owner thereof may kill them, but must furnish State game and fish commissioner with affidavit describing real estate and showing damage and number killed. Skins of animals so taken must be tagged immediately (fee, $1.50 each).

Shipment and export: Beaver skins must be tagged by commissioner before being shipped or transported.

Miscellaneous: Use of flesh of game animals or birds as trap bait for predatory animals prohibited.

Propagation: Beavers and other fur animals may be taken for propagation under a $10 permit, but animals so taken must be kept three years before being killed or sold.

Bounties: Bobcat, coyote, gray or black wolf, $3; mountain lion, $15.

LAWS OF CANADA

ALBERTA

Open seasons: [3]	*Dates inclusive*
Bear (except cubs or bear with cub)	Sept. 1–June 14.
Fox [4]	Nov. 1–Feb. 29.
Mink, fisher, marten, red squirrel	Nov. 1–Mar. 31.[5]
Otter	Nov. 1–Apr. 30.
Muskrat,[6] south of North Saskatchewan River	No open season.
North of Township 90	Feb. 15–May 15.
In rest of Province	Feb. 15–Apr. 15.
Beaver [5] [6]	No open season.
Other fur animals	No close season.

Prohibited methods: Unlawful to use poison for taking fur animals; or to destroy, partially destroy, or to leave open any muskrat or beaver house or beaver dam, or, except under permit, spear or shoot muskrats.

Licenses: Trapping: $2 (issued to resident only); issued by minister of agriculture. License not required of farmer or member of his family while actually residing with him upon his farm. Consent of owner or occupant required to trap on inclosed or cultivated lands of another. Permits to trap on game or forest reserves may be granted under regulations of lieutenant governor in council. Taxidermist, $5. Dealer in furs and skins of protected animals at a specified place of business, or within 1 mile thereof: Resident of a city, $25; resident outside of a city, $10; nonresident, $100. Traveling license issued to holder of a dealer's license or his manager upon payment of fee of $15. Traveling buyer: Resident, $25; nonresident, $100. Nonresident buying wholesale from licensed dealers, $5 (good for 10 days only). Licensee must make semiannual reports to department of agriculture. License to sell skins by tender or auction, fee, $25. Issued by minister or agents.

Bag limits: One bear of each species a season.

Possession and sale: No restrictions on prime skins legally taken and possessed. Under special permit, unprime pelts of mink, muskrat, and beaver may be possessed, bought, and sold.

Shipment and export: Export of furs and skins prohibited except under permit from minister. No furs or skins on which royalty has not been paid may be exported, and a special permit from the minister is necessary to ship out unprime skins. Export of live wild foxes prohibited.

Propagation: Manager of fur farm required to make reports January 1 and July 1 of each year. Export of live animals from fur farms allowed only on permit from the minister of agriculture. Permit, with fees, required to export live muskrat, mink, fisher, marten, otter, or beaver, whether raised on a fur farm or otherwise (orders in council).

Bounties: Timber wolves, male, $10, female, $20. Prairie wolf taken between April 30 and September 1, $2.

BRITISH COLUMBIA

Open seasons: [7]	*Dates inclusive*
Eastern district: [8]	
Beaver, muskrat (see exception)	Mar. 1–May 15.
Exception: In that portion of district south and east of line from Birken, following Pacific Great Eastern Railway to Lillooet railway station, thence east to Canadian National Railway at Ashcroft, thence following Canadian National Railway north and east to Alberta line	Mar. 1–Apr. 15.
Otter (except sea otter) (see exception)	Dec. 1–May 15.
Exception: In that portion of district south and east of line from Birken, following Pacific Great Eastern Railway to Lillooet railway station, thence east to Canadian National Railway at Ashcroft, thence following Canadian National Railway north and east to Alberta line	Dec. 1–Apr. 15.
Other fur animals	Nov. 1–Feb. 29.
Bear (hunting) (except white or Kermodei bear)	Sept. 1–June 30.
Western district: [8]	
All fur animals (except sea otter) (see exception)	Dec. 1–Feb. 29.
Exception: Beaver, on Vancouver Island	No open season.
Bear (hunting) (except white or Kermodei bear)	Sept. 15–June 30.

Prohibited methods: Bears may not be trapped. Unlawful to poison fur animals, except that farmers and poultrymen may protect own stock; to destroy muskrat or beaver houses, except under permit to prevent damage on diked or agricultural lands; or to hunt fur animals at night or use pit lamp. Possession of unprime pelts by trader or trapper prohibited.

Bag limits: Two grizzly bears and three of any other species a season.

Licenses: Trapping: Resident, British subject, $10; nonresident or resident alien not permitted to trap; nonresident general hunting license, fee $25, and additional fees of $15 to $25 for each bear killed. License not issued to boys under 18 without written consent of parent or guardian. Issued by provincial game commissioner or authorized agent. Licensee must wear badge. Permission of owner required to trap on inclosed, cleared, or cultivated land of another. Mainland trappers must register trap lines, and licensed trapper who first occupies a trap line not later than 15 days after beginning of any open season for trapping is protected against other trappers. Unlawful to touch or interfere with traps set by licensed trapper. License must be returned within two months after it expires, with a statement of number of fur animals of each kind taken. Fur dealer: Resident, $25 (does not apply to licensed trapper selling skins taken by himself); nonresident or his agent, $200. License required for each place of business. Fur dealer must make verified report every three months, showing number and kind of skins purchased and date of transactions. Taxidermist, $5; tanner, $5. Provincial game commissioner may grant free permit to buy furs at wholesale from licensed fur dealers or at public auction.

---

[3] *Alberta:* Lieutenant governor in council may change close season on fur animals.

[4] Unlawful to trap foxes for export.

[5] Unlawful to destroy beaver dam unless authorized to do so by lieutenant governor in council, who may also authorize killing of beavers or other fur animals when such killing is deemed to be in public interest.

[6] Lieutenant governor in council may declare open seasons locally on beavers and muskrats.

[7] *British Columbia:* Seasons on fur animals, fixed annually by lieutenant governor in council, may be obtained from provincial game commissioner, Vancouver.

[8] Western district includes that portion of Province west of summit of Cascades and south of Atlin electoral district. Eastern district includes rest of Province.

Possession and sale: Bear (except white or Kermodei bear) may be sold in eastern district from September 1 to June 30, and in western district from September 15 to June 30. Unlawful to sell pelts taken during close season or to possess unprime furs. Possession of pelts of fur animals allowed only during open season, and for two months thereafter (three months, north of fifty-second parallel), except under special permit from provincial game commissioner. Royalties must be paid on all furs exported or shipped to a tanner within Province.

Shipment and export: Export of pelts of fur animals allowed only under special permit of provincial game commissioner. Packages must be prepared so that they may be easily opened for examination, or labeled with full description of contents, and names and addresses of consignor and consignee, and accompanied by export permit. Importation of live animals prohibited except under permit.

Propagation: A permit from provincial game commissioner is required to propagate fur-bearing animals or to take them for breeding purposes. Breeder must keep record of transactions as to purchases and sale of stock, which record must be open to inspection of any game warden, and must make verified report to provincial game commissioner on or before August 31. Live animals and birds may be exported only under permit; and a permit is required to take foxes or other fur animals in close season.

Bounties: Panther, $40; timber wolf, $25; coyote, $2 (if not less than 1 week old). (Rates fixed from time to time by lieutenant governor in council.)

MANITOBA

Open seasons:[9]	*Dates inclusive*
North of fifty-third parallel—	
Fisher or pekan, sable, marten, mink	Nov. 1–Mar. 15.
Otter	Nov. 1–Apr. 30.
Muskrat	Mar. 15–May 15.[10] [11]
Fox (other than Arctic, blue, and white), lynx	Nov. 1–Feb. 15.
Fox, Arctic (blue and white)	Nov. 1–Mar. 31.
Beaver	No open season.[11]
South of fifty-third parallel—	
Fisher or pekan, sable, marten, mink	Nov. 1–Feb. 29.
Otter, beaver [11]	No open season.
Muskrat	Mar. 15–Apr. 30.
Fox, lynx	Nov. 1–Jan. 31.

Prohibited methods: Use of poison or dog in taking or hunting fur animals is prohibited. Unlawful to shoot or spear muskrats or to destroy or molest den of any fur animal. Beaver and muskrat houses and dams protected, except under permit to protect property. Unlawful to allow dogs in marsh during open season on muskrat.

Licenses: Trapping: Resident, $2; nonresident British subject, $100; issued by minister of mines and natural resources. Permission of owner required to trap on cultivated or inclosed lands of another. Licensee must return his license and make report during month of June, showing number of each kind of animals taken. Fur trading licenses issued by minister under regulations and at fees fixed by order in council. Licensees are required to keep record and to make monthly reports of furs handled. Fur dressing and tanning, $10; issued by minister. Licensee must keep records and report to chief game guardian on or before 10th of each month number of royalty pelts handled and name and address of person forwarding or delivering skins. Royalties of varying amounts must be paid on undressed skins or pelts of fur animals, except those imported or ranch bred.

Possession and sale: Possession of unprime skins prohibited. Unlawful to purchase or sell skins of muskrats that have been speared or shot. Any person purchasing or acquiring pelts from a trapper must have license or permit, and must ascertain that trapper holds proper trapping permit and at same time record his name and number of his permit. Unlawful to purchase, barter, or trade pelt of a fur animal taken during the close season (does not apply to imported skins). Unlawful to possess pelts in close season except under permit. No other restrictions on skins legally taken.

Shipment and export: Export prohibited of unprime skins or skins on which royalty is payable unless such shipment is accompanied by permit procured from minister and has attached a declaration of number and kinds of skins contained. Shipment or removal from Province prohibited except by express or mail. No other restrictions on skins legally taken. Export prohibited of live protected animals (except ranch-bred animals) except under permit from minister of mines and natural resources (permit must accompany shipment to destination); fees, for black or silver fox, $100; for other fox, $15; for otter, $25; for beaver, $15: mink, $10; fisher, $30; marten, $15; muskrat, 50 cents.

Propagation: License (fee, $5) must be obtained from minister to operate a fur farm other than a muskrat farm. Muskrat farm or ranch of 160 acres or less, fee $5 and $1 for each additional 100 acres. Licensee, from time to time, as prescribed by lieutenant governor in council, must make verified reports showing number, species, age, and sex of animals on hand, from whom procured, and number that have died during previous 6 months, with cause of death. Permits may be issued for the taking of fur animals for breeding, at fees provided for each species.

Bounties: Timber wolf,[12] $5; other wolf, $2; half is refunded to municipality by provincial treasurer.

NEW BRUNSWICK

Open seasons:	*Dates inclusive*
Otter, fisher, marten or sable	Nov. 1–Mar. 31.
Mink, fox, raccoon	Nov. 1–Feb. 29.
Muskrat (see exception)	Mar. 25–May 1.
Exception: In Carleton, Gloucester, Kent, Madawaska, Northumberland, Restigouche, and Victoria Counties	Mar. 25–May 25.
Beaver	No open season.[13]
Other fur animals	No close season.

Prohibited methods: Unlawful to take fur animal by use of poisons, with aid of hounds, or with gun equipped with silencer; to dig out foxes or muskrats from their homes or earth burrows; or to shoot muskrats.

Licenses:[14] Trapping, and buying and selling raw furs: Resident, $10; nonresident, $50. Fur dealers must furnish minister with written declarations showing their names and addresses, location of warehouses, shops, posts, or caches where skins are to be stored and places from which skins will be shipped out of Province, and must make monthly reports of operations. Issued by minister of lands and mines.

Possession and sale: Possession prohibited of furs on which royalties, as fixed by lieutenant governor in council, have not been paid; possession of green skins or carcasses of protected fur animals in close season prohibited.

---

[9] *Manitoba:* Lieutenant governor in council may shorten current open season on fur animals. Trapping in provincial game preserve prohibited, except as provided in regulations.

[10] Muskrat season opens and closes at noon.

[11] Director of game and fisheries may take necessary steps to prevent damage by beavers or muskrats, but pelts so taken must be reported within 10 days and may not be sold except under permit and payment of $1 royalty on each skin.

[12] Poison may not be used to capture wolves for bounty.

[13] *New Brunswick:* Expires Nov. 1, 1935.

[14] Trapping license not required of bona fide resident unless his raw furs are sold outside of Province.

Shipment and export: Skins legally taken, possessed, stamped, tagged, and on which royalty has been paid, may be exported under permit from minister. Permit from minister required to export live fur animals.

Propagation: Permits to capture wild fur animals for propagation within Province may be obtained from minister, who fixes fee for such permit.

Bounties: Wildcat, bear, $5.

NORTHWEST TERRITORIES[15]

Open seasons: [16]	*Dates inclusive*
Mink, fisher, marten, lynx	Nov. 1-Mar. 31.
Beaver (see exception)	Jan. 1-May 15.
Exception: In Mackenzie district	No open season.[17]
Otter, north of Arctic Circle	Nov. 1-May 15.
South	Nov. 1-Apr. 30.
Muskrat, north of Arctic Circle	Mar. 1-June 15.
South	Mar. 1-May 31.
Fox (other than Arctic, blue and white), north of Arctic Circle	Nov. 1-Mar. 15.
South	Nov. 1-Feb. 28.
Fox, Arctic (blue and white), north of timberline	Nov. 16-Mar. 31.
South	Nov. 1-Feb. 28.

Prohibited methods: Unlawful to use automatic rifles, revolvers, shotguns, dogs, or poison in taking fur animals, or to destroy or injure any muskrat or beaver house or beaver dam.

Licenses: Trapping: Resident, $2; nonresident British subject, $75; other nonresident, $150. Fur dealer or trader or trafficker in furs: Resident, $5; nonresident British subject, $150; other nonresidents, $300. Fur farm, $5 (renewal, $2). Issued by director of Northwest Territories. License not required of native-born resident Indian, Eskimo, or half-breed. Licensed trappers, and Indians, Eskimos, and half-breeds, must report to nearest game officer number of fur animals taken. Permit, fee $1, of minister required to establish trading post.

Possession and sale: Licensed trapper may sell or trade skins of animals he has legally taken. No restrictions on skins legally taken.

Shipment and export: Furs legally taken may be exported under permit of minister if stamped or sealed by permit officer upon payment of fur export tax.

Propagation: Fur-farm license, fee $5 (renewal, $2). Fur animals may be captured for propagation under permit. Fees: $2 for each animal, except muskrat (25 cents each) taken. Limit, 100 muskrats, 20 of each other species. Export of such animals prohibited except under permit. Fees: $10 (20 muskrats, and 50 cents for each additional muskrat; limit 100); other fur animals $10 each, limit 6 of each species. Licensee must keep records and render annual report. Pelts of fur animals raised in captivity subject to regulations governing shipment of other furs.

Bounties: Timber wolf, $30; coyotes, $15 (skin must be surrendered).

NOVA SCOTIA

Open seasons: [18]	*Dates inclusive*
Beaver, marten, fisher	No open season.
Bear, wolf, wildcat	No close season.
Muskrat	Mar. 1-Apr. 30.
Other fur animals	Nov. 15-Jan. 31

Prohibited methods: Unlawful to take any protected fur animal by use of poison; to damage or molest beaver dam or house or muskrat house or to set snare or trap within 25 feet of the latter. Unlawful to set a slipknot snare for foxes.

Licenses: Trapping: Resident, $1; nonresident, $50; issued by minister of lands and forests. Traps must bear an aluminum tag stamped with license number. Fur buyers: Nonresident, $100; resident, $25; issued by minister of lands and forests. Fur buyer must keep record and make monthly report of number of skins bought or sold, together with names and addresses of parties from whom purchased or to whom sold. Taxidermist, $5. Royalties of varying amounts must be paid on all furs, except bear, wolf, and wildcat.

Possession and sale: Unlawful to possess or sell green hide of any beaver, fisher, or marten, or to possess green hide of any fur animal taken out of season or pelts on which royalty has not been paid. No other restrictions on skins legally taken.

Shipment and export: Unlawful to export skins of fur animals except under certificate of inspection and permit (fee, 50 cents) from a game inspector and payment of royalty.

Propagation: Unlawful to keep fur-bearing animals, except silver foxes, in captivity for breeding purposes without a permit from minister of lands and forests; fee, $2 for each kind of animal kept except silver fox, payable annually. Reports are required annually on December 31. Unlawful to trespass on inclosures for fur animals.

Bounties: None paid.

ONTARIO

Open seasons: [19]	*Dates inclusive*
Mink, fisher, marten, fox	Nov. 1-Feb. 28.
Raccoon	Nov. 1-Dec. 31.
Muskrat (see exception)	Apr. 1-May 21.
Exception: South of French and Mattawa Rivers	Mar. 15-Apr. 21.
Beaver, otter, north Canadian National Railway	Dec. 15-Mar. 31.[20]
South	No open season.
Other fur animals	No close season.

Prohibited methods: Unlawful to shoot or spear muskrat, beaver, or otter, to injure or destroy any muskrat or beaver house or beaver dam, or to set trap closer than 5 feet to muskrat house or 20 feet to beaver house, or to destroy dens of fur animals, except wolves. Trapper may not possess poison.

Licenses: Trapping, $5 (issued to resident only); issued by department of game and fisheries. License not required of residents to take bears, wolves, or foxes by means of gun or dog. Only resident Indians permitted to take beavers or otters, and then only north of Canadian National Railway. Farmers and their sons may trap on own land during open season without license. Fur dealers or traders: Resident, British subject, $25 (store license), $100 (traveling fur buyers), $100 (wholesale license); resident, $1 (restricted—buying for personal use); alien or nonresident, $200; nonresident, $5 (buying from wholesalers); licensee must make reports monthly. Fur dressing and tanning, $10; licensee must keep records and make monthly reports.

---

[15] *Northwest Territories* means the northwest territories formerly known as Ruperts Land and the Northwestern Territory (except such portions thereof as are included in Provinces of Ontario, Quebec, Manitoba, Saskatchewan, and Alberta, and Yukon Territory), together with all British territories and possessions in North America and all islands adjacent thereto not included within any Province, except Dominion of Newfoundland and its dependencies.

[16] Trapping prohibited in Peel River, Yellowknife, Arctic Islands, and Slave River Preserves, which have been reserved as hunting and trapping grounds for native Indians, Eskimos, and half-breeds.

[17] Royal Canadian mounted police and Indian agent may issue permit to one member of needy Indian or half-breed family leading Indian life, to trap not more than 15 beaver between Jan. 15 and May 15 in the Mackenzie district, and pelts of such animals may be sold under regulations to licensed trader. Permittee must report number taken and disposition of pelts.

[18] *Nova Scotia:* Fox, raccoon, skunk, weasel, or muskrat may be killed on one's own inclosed premises at any time for protection of private property.

[19] *Ontario:* Fur animals may be destroyed in defense of property, but skins so taken must be reported within 10 days, and may not be sold during close season except under permit from minister.

[20] Beavers and otters may be taken only by resident Indians north of Canadian National Railway, and then only in the district in which they live. Under special permit from minister, overseer or other officer may take or kill beavers doing damage to roads or private property.

Possession and sale: Possession of furs during close season and sale of unprime skins prohibited, except under permit. Unlawful to have skins dressed, plucked, or treated in any way except under permit obtained upon payment of royalties. Skins of beavers and otters lawfully taken must be disposed of within 10 days after close of open season.

Shipment and export: Export prohibited except under permit obtained upon payment of royalties. No other restrictions on skins legally taken, possessed, or tagged; shipments must be made by express or parcel post and packages must be marked with list of contents and names and addresses of consignor and consignee.

Propagation: Permit is required of breeders of game or fur animals (fee, $5, 50 acres or less). Licensed fur breeders may sell live animals or skins during open season upon payment of royalties. Minister may grant permits to take limited number of fur animals for propagating purposes during close season, upon payment of prescribed fees.

Bounties: Adult wolf, $25; wolf pups under 3 months old, $5; when paid by county provincial treasurer refunds 40 per cent. Provincial treasurer pays entire bounty in unorganized counties.

PRINCE EDWARD ISLAND

Open seasons:	*Dates inclusive*
Otter, marten, mink, muskrat, raccoon	Nov. 1–Mar. 31.
Beaver	No open season.[21]
Fox	Dec. 1–Jan. 31.
Other fur animals	No close season.

Prohibited methods: Unlawful to put out poisoned baits for fox or other animals. Beaver dams protected.

Licenses: Trapping: None required of resident; nonresident, $50; issued by secretary-treasurer of Province. Game inspector may grant permits to take beaver and issue coupons (fee, $1, each) to tag skins of animals taken.[21]

Possession and sale: Possession and sale during close season prohibited. Holders of permits may possess, buy, or sell beaver skins that have proper coupons attached.

Shipment and export: No restriction on animals legally taken, possessed, and tagged.

Propagation: Several special acts of provincial legislature regulate fox ranching on island. Animals are assessed for taxation, ranches are protected from trespass under heavy penalties, and incomes from ranches are taxed.

Bounties: None paid.

QUEBEC

Open seasons:	*Dates inclusive*
Bear	Aug. 20–June 30.
Beaver [22]	No open season.
Muskrat (see exception)	Nov. 1–May 31.
Exception: South of 50th parallel	Mar. 15–Apr. 30.
Fox	Nov. 1–Feb. 29.
Otter	Dec. 15–Mar. 31.
Other fur animals	Nov. 1–Mar. 31.

Prohibited methods: Use of poisons in taking fur animals prohibited. Beaver houses protected, and traps may not be set within 20 feet thereof.

Licenses: Resident, $5; nonresident, $200. Not required of resident for trapping on own land. Resident British fur dealer, $25; fur peddlers purchasing for themselves or as agents, resident British, $100; resident alien, $200. Resident wholesalers, British, $100. Dealers in dressed and prepared furs, $10. Fur tanners and dyers, $10. Dealers and buyers must make monthly reports.

Possession and sale: Beaver skins must be tagged. No other restrictions on skins legally taken and on which royalty has been paid.

Shipment and export: Shipment and export prohibited, except of fur animals or furs on which royalties have been paid. Skins must be shipped open to view and each skin must be stamped to show royalty paid and be tagged as prescribed by minister before being shipped in any manner. Packages must show names and addresses of consignor and consignee.

Propagation: Minister may grant permits to take or keep animals alive for breeding purposes.

Bounties: Wolf, $25.

SASKATCHEWAN

Open seasons: [23]	*Dates inclusive*
Beaver (1931)	No open season.[24]
Fox, raccoon	Oct. 20–Jan. 15.
Badger	Dec. 1–Feb. 29.
Mink, fisher, marten, lynx	Nov. 1–Mar. 31.
Otter	Nov. 1–Apr. 30.
Muskrat: [24]	
North of Township 52	Mar. 1–May 14.
South Township 53	Mar. 1–Apr. 15.
Other fur animals	No close season.

Prohibited methods: Unlawful to use poison to take fur animals, to snare wolves, coyotes, or foxes, to spear or shoot beavers, or muskrats, or to molest or destroy beaver dams or houses, or muskrat houses or to trap beavers or muskrats in their houses. No traps may be set north of Township 64 before Oct. 20.

Licenses: Trapping: Resident, $2 (children or wards under 18 of licensee may trap on his land under his license); nonresident domiciled in Canada, $25; alien, $50; resident licensee must return license on or before May 31 to game commissioner with statement showing number of each kind of fur animals taken by him. Fur dealer: Resident, $10 (store); traveling dealer, $50; traveling agent for resident dealer: Permit, $50, $10 for permit north of Township 56; nonresident, $50 (store); traveling agent for nonresident or nonresident traveling dealer, $100; nonresident traveling fur dealer, 15-day license, $10; wholesale dealer, $100. All other licenses, $100. Taxidermist: $5; licensee must keep duplicate receipt book and furnish a copy thereof every 3 months to the minister. Tanner: $1; licensee must keep record and make monthly report. Issued by department of agriculture, Regina. Licensed fur trader must make monthly and annual reports of operations. Resident treaty Indians may trap during open season without a license. Consent of owner or occupant required to trap on inclosed or cultivated lands of another.

Possession and sale: Unlawful to buy, sell, or possess unprime pelts of protected fur animals.

Shipment and export: Packages containing fur animals must be plainly marked with full description of contents and names and addresses of consignor and consignee. Export of live fur animals prohibited except under permit of minister; fees for black or silver fox, $25; for cross or red fox or other live fur animal, $5. Unlawful to ship unprime furs or to export any raw furs on which royalty has not been paid or to export raw or undressed pelts except under special permit. No other restrictions on skins legally taken.

Propagation: Permit required (fee, $5 annually) to operate a fur ranch. Permittee may ship live fur animals bred in captivity upon exhibiting fur farm permit to express agent.

Bounties: Adult timber wolf, $10; pups of prairie or timber wolf, $1; paid only in properly gazetted wolf districts, when half is refunded from provincial treasury.

---

[21] *Prince Edward Island:* Beavers may be taken under special license (see Licenses). They may be destroyed by owner of private property on which they are locating and building dams, and, under permits from game warden or lieutenant governor in council, their dams may be destroyed when necessary to prevent damage to property.

[22] *Quebec:* Indians residing north of Canadian National Railway may take beavers, under permit from minister, in certain prescribed area, Dec. 15–Mar. 31. Minister may have beavers taken at any time for protection of property.

[23] *Saskatchewan:* Lieutenant governor in council may alter seasons. Trapping on game preserves prohibited.

[24] Minister may authorize council of any municipality to destroy beavers or muskrats doing damage to highways or other public improvements.

YUKON

Open seasons: [25]	*Dates inclusive*
Beaver north of Artic Circle	Jan. 1–June 15.
South of Artic Circle	Jan. 1–May 15.
Muskrat, otter (see exceptions)	Jan. 1–June 30.
Exceptions:	
Muskrat, south of Arctic Circle	Dec. 1–May 31.
Otter, south of Arctic Circle	Jan. 1–May 15.
Lynx, marten, mink	Nov. 15–Apr. 1.
Fox (see exception)	Nov. 15–Mar. 31.
Exception: South of Arctic Circle	Nov. 1–Jan. 31.
Other fur animals	No close season.

Prohibited methods: Use of poison, pitfalls, spears, or similar devices prohibited. Traps must be taken up within 15 days after close of open season. Unlawful to shoot beaver, or to dig up or destroy beaver dam, runway, or house.

Licenses: Trapping: None required of resident; nonresident, $100. Fur buyer or dealer (purchasing furs for sale or export): Nonresident, $150; resident, $25; mercantile establishment buying furs, $25 (required for each place of business other than head office), issued by gold commissioner or person designated by him.

Possession and sale: Skins legally taken may be possessed and sold at any time.

Shipment and export: Export of raw furs prohibited except under permit issued by territorial secretary or authorized agents, and upon payment of the export tax. Export of live foxes prohibited. (See Propagation.)

Propagation: Registration of fox breeders required. Unlawful to export a fox not born in captivity or which has been in captivity for less than a year; any fox born in captivity may be exported under a permit (fee, $5). Fox and other fur ranches, if posted against trespass, may not be approached without owner's consent. Live foxes may be captured for breeding purposes, May 1–Nov. 1, but use of steel trap or wire snare prohibited. No restrictions on other fur animals.

Bounties: Wolf, not more than $20; coyote, not more than $10.

---

[25] *Yukon:* Commissioner in council may alter seasons.

LAWS OF NEWFOUNDLAND

Open seasons: [26]	*Dates inclusive*
Otter, marten, lynx	Oct. 1–Mar. 31.
Fox	Oct. 15–Mar. 15.
Muskrat	Oct. 1–Apr. 30.
Beaver	No open season.[27]

Prohibited methods: Beaver house or dam must not be damaged by trapper. Use of poisons and wire snares prohibited.

Licenses: Trapping: None required of residents; nonresident, $501; issued by game and inland fisheries board or authorized agents. Fur buyer and shipper, 50 cents; issued by game and inland fisheries board. Fur buyer must report operations semiannually on or before June 30 and December 31 of each year.

Possession and sale: No restrictions on skins legally taken, except beaver.

Shipment and export: Unlawful to export a live fox unless raised in captivity and then only under permit. No restrictions on skins legally taken.

Propagation: No restrictions, except as to fox. A fox farm must be licensed; the owner must at stated times make reports to game and inland fisheries board, and premises must be at all times open to inspection by officers of the board. Possession of fox cub or fox taken in close season is prohibited. Unlawful to export a fox not bred on a fox farm, or without permit from board to export a fox bred in captivity.

Bounties: Crow, 50 cents.

---

[26] *Newfoundland:* Unlawful to trap on Grand Lake Caribou Preserves.

[27] Governor in council may proclaim open season on beavers in certain localities, when not more than 25 may be taken by resident trapper of three years' standing, under beaver-trapping license. Skins of beavers must be forwarded through magistrate to game and inland fisheries board, which has sole power to purchase or export.

LAWS OF MEXICO [28]

Open seasons:	*Dates inclusive*
Bear	Sept. 1–Oct. 31.
Fur-bearing animals	Nov. 1–Feb. 28.
Kinkajou	Oct. 1–Jan. 31.

Open seasons—Continued.	*Dates inclusive*
Armadillo	Nov. 1–Jan. 31.
Alligator	Sept. 16–May 31.

---

[28] *Mexico:* For further information concerning trapping and fur laws, communicate with Secretaria do Agricultura y Fomento, City of Mexico.

UNITED STATES GAME PROTECTORS OF THE BUREAU OF BIOLOGICAL SURVEY

[Violations of the Federal Lacey Act, prohibiting shipment by common carrier of the dead bodies of wild animals, or parts thereof, including the skins of fur-bearing animals, that have been killed or shipped contrary to State law, may be reported to the nearest official listed below, or to the Chief, Bureau of Biological Survey, United States Department of Agriculture, Washington, D. C.]

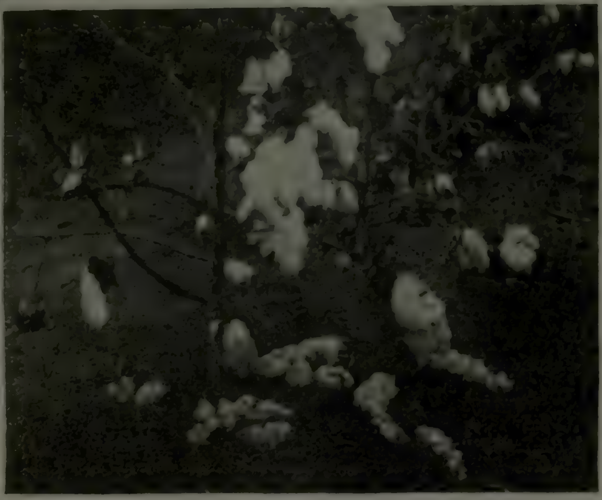
Harry Barmeier,
4947 Schollmeyer Avenue, St. Louis, Mo.
William L. Birsch,
Box 177, New Bern, N. C.
Louis A. Branchaud,
Biological Survey, Washington, D. C.
B. R. Britten,
Box 185, Socorro, N. Mex.
M. A. Charlton,
2106 Summit Street, Columbus, Ohio.
Frank Clarkson,
Box 1108, Houston, Tex.
Stephen Creech,
Box 306, Peoria, Ill.
P. S. Farnham,
Owego, N. Y.
———
Mobile, Ala.
John Q. Holmes,
1514 Howard Street, Omaha, Nebr.
Floyd A. Johnson,
Watertown, S. Dak.
Jay V. Kelsey,
Box 1825, Daytona Beach, Fla.
Chester A. Leichhardt,
516 Post Office Building, Portland, Oreg.
S. W. Linebaugh,
Russellville, Ky.
Lawrence J. Merovka,
318 Federal Building, Memphis, Tenn.
John E. Perry,
Sherman Hotel, Kansas City, Mo.
W. H. Ransom,
Box 94, Spokane, Wash.
George M. Riddick,
Box 815, Little Rock, Ark.
Kenneth F. Roahen,
Box 438, Billings, Mont.
B. J. Shaver,
General Delivery, St. Paul, Minn.
Bertrand E. Smith.
21 Rosemont Avenue, Portland, Me.
Albert Stadlmeir,
45 Loraine Avenue, Pleasantville, N. J.
Orin D. Steele,
125 Willis Street, Cambridge, Md.
George Tonkin,
Box 399, Berkeley, Calif.
E. B. Whitehead.
532 East Fiftieth Street, Savannah, Ga.

U. S. GOVERNMENT PRINTING OFFICE: 1931

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No 1686

COMMON ERRORS IN COTTON PRODUCTION



IMPROVEMENT of cotton production in the United States depends largely upon getting rid of numerous errors in production practice which are widely current and commonly overlooked, even among well-informed people.

General disregard of quality in cotton buying, effects of mixing and changing seed, of planting inferior varieties, and of carelessness in handling and ginning the cotton are discussed in this bulletin.

Progressive farmers and local leaders are advised to direct their efforts toward establishing community production of single varieties of cotton. Without such production there is little possibility of making effective use of superior varieties or of obtaining advantage from other improvement measures.

In the absence of any domestic use for raw cotton a higher return from his cotton is the only benefit which the farmer can expect from improvement of its quality. If better varieties are to be grown extensively, cotton must be bought on a basis of quality and not at "hog-round" prices. Organized community production of one variety will facilitate this change. There can be no assurance of better prices for better cotton except in communities which produce uniform standardized fiber in commercial quantities.

Washington, D. C. Issued January, 1932

COMMON ERRORS IN COTTON PRODUCTION

By **O. F. Cook**, *Principal Botanist, Division of Cotton, Rubber, and Other Tropical Plants, Bureau of Plant Industry*

CONTENTS

Page
Mistakes that interfere with progress 1
Causes of deterioration 3
General measures of improvement 4
  Changing the method of buying cotton .. 4
  Organizing 1-variety communities 5
Some causes of inferior cotton 7
  Planting poor seed 7
  Planting on price conjectures 9
  Changing the seed 10
  Planting too many varieties 11
  Failure to test varieties 12
  Misleading claims for varieties 13
Some causes of inferior cotton—Continued.
  Propagating hybrids 14
  Planting unsuitable land 14
  Planting too early 14
  Thinning too early 15
  Spacing too wide 15
  Picking too late 17
  Breeding weevils in the fall 18
  Mixing seed at public gins 19
  Ginning too close 21
  Ginning too wet or too dry 23

MISTAKES THAT INTERFERE WITH PROGRESS

COTTON growers hold several mistaken ideas which interfere with the adoption of improved methods and varieties, and thus tend to keep the producing industry backward and wasteful. Mongrel seed is planted, millions of bales of inferior cotton are produced, cultural practices that invite weevil injury are used, and careless handling and bad ginning do great damage. Much cotton must be sold without proper discrimination of quality[1] in the primary markets and without adequate encouragement to farmers who have tried to improve the quality of their crop.

Some of the popular beliefs are supported by arguments that appear reasonable and have been held so long without challenge that they now have the force of accepted traditions. Thousands of farmers plant the varieties with the shortest lint and are certain that such varieties always give the highest yields, although they often do not, as many experiments have shown. The mistake no doubt arises from the fact that some of the very short varieties give high turnouts at the gin, though the yields per acre often are lower than in varieties that produce longer and better lint. The mistake of planting poor seed instead of using good varieties affects the entire cotton industry and entails a loss every year of many millions of dollars.

Probably a large proportion of farmers still have confidence in the idea that cotton varieties inevitably "run out" and that a change of seed is required every few years. The notion of changing the seed undoubtedly is responsible for much mixing and mongrelizing of seed stocks and consequent deterioration of the fiber.

---

[1] Much remains to be done in determining precisely what is meant by "quality" as related to cotton and its utilization. Progress is being made in a cotton research program of the U. S. Department of Agriculture, which, in cooperation with various Federal, State, and other agencies, embraces cotton fiber and spinning studies by the Bureau of Agricultural Economics.

Such errors are not confined to farmers and cotton buyers, but are shared by many economists, engineers, and statesmen. Even many professional writers on farm improvement, plant experimenters, and cotton breeders reflect the traditional views. Bankers, factors, and merchants who lend money to the farmers are often completely misinformed on seed questions and in recent years have suffered with the farmers through overproduction of inferior fiber. In view of such losses it is remarkable that they should continue to advance millions of dollars every year for the production of inferior cotton, without giving more consideration to the need for improvement.

Information, advice, or instructions for improving the cotton crop can be of little use while farmers continue to believe that they can get larger returns from poor varieties, and that they should have the ginner "skin" the seeds in order to increase the bale weights. Little interest in quality is felt by farmers who have contracted beforehand to deliver so many bales of cotton at a specified price to cover their loans. The causes of such backwardness must be recognized and removed before the farmers can be expected to apply themselves seriously to the improvement of their crop. Indeed, they sometimes prefer to have their cotton as poor as possible, as this has been their only way of retaliating against the unfairness of the commercial system.

Improving the quality of the domestic cotton crop is important in meeting the competition from cotton grown in other countries and sold in the world market, as well as in giving domestic manufacturers a better staple. Very short fiber grown in the the United States must be sold in competition with cotton grown in India and China, or it must be held as a surplus stock in this country which tends to depress prices.

Gradually increasing cotton production is reported from several regions. In Cotton and Cotton-Oil News, January 6, 1930, the following statement was made:

> A glance at the daily spot sales in the Liverpool market is enlightening. Without going very far back or digging deeply into the matter, it is evident that foreign cotton is playing a great part in the dealing there. For some time it has been a regular occurrence to see the sales of foreign cotton amounting to 40 or 50 per cent of the daily total. It is at least interesting to note the details of the stocks of cotton held in Great Britain at the end of November this year and last year, as follows:

	1929	1928		1929	1928
	Bales	*Bales*		*Bales*	*Bales*
Brazilian	66, 810	24, 000	East African	47, 740	42, 000
Peruvian	99, 770	71, 000	West African	21, 920	9, 000
Egyptian	47, 040	53, 000	Australian	330	2, 000
Sudan	80, 910	42, 000	East Indian	39, 520	38, 000
West Indian	3, 650	1, 000			

CAUSES OF DETERIORATION

Two important agencies of deterioration existed in the cotton industry for many years without being recognized, and even yet their adverse effects are only partially understood by cotton growers generally and still less by the manufacturers. The public gins and the commercial system of indiscriminate buying have been responsible for a deterioration in the quality of the American cotton crop. Indeed, it is hard to understand how their effects upon the crop could have remained so long unrecognized. Some of the errors that affect production undoubtedly are deeply embedded in the commercial system and are hardly to be removed unless the methods of buying cotton can be changed.[2]

Although mechanically more efficient than the old plantation gins in handling large quantities of cotton, the present-day public gins have serious drawbacks in the fact that in them the cotton and the seed from different customers are mixed together, and this undoubtedly is a general cause of deterioration of the crop. Different kinds of cotton follow each other at the gin, and "plated" bales and mixed seed stocks result.

To maintain pure stocks of seed, individual farmers must not only isolate the fields where seed for planting is grown but must take special precautions against mixing the seed at the gins.

The present buying system does not encourage production of a better quality of cotton because, on many primary markets, the crop is bought at "hog-round" prices, with no discrimination between staple lengths or qualities of the fiber. Price levels may be higher in districts reputed to produce fiber of better quality, but this usually does not mean that the individual growers of good cotton can sell at a better price than the growers of poor cotton. It is easier and more profitable to the cotton buyer to buy in this manner. Buyers say they favor the production of better fiber, but they seldom offer the practical encouragement of a better price for it. The farmer who produces fiber worth from 2 to 5 cents a pound more than a neighbor's cotton raised from gin-run seed may have to sell his cotton at the same price that the neighbor's cotton brings, because the buyer refuses to consider quality and offers only one price, which the farmer must take or leave. Under such conditions the farmer naturally remains indifferent to the possibilities of producing better fiber.

It may be argued that indiscriminate buying is appropriate to the present method of production from mixed and miscellaneous seed stocks. Each farmer's bale may be different from his neighbor's, and mixed or "plated" bales are frequent, even when there is no intention to swindle the buyers. Plated bales may have to be repacked before they can be marketed, and this is a costly operation. Bales are not classed to any great extent in the primary markets, but at the trade centers where thousands of bales are assembled and the work can be done rapidly.

Much cotton is grown on advances of borrowed money, but banks and other financial agencies have not taken a constructive interest in the quality of the crop. Little change in the economic phases of cotton growing has taken place in the two generations since the Civil War. In the early days of the boll-weevil invasion it was thought that the industry might be freed from the crop-loan system, but the system has spread into new cotton-growing areas north and west, and has even extended gradually to the production of other crops, especially in the cotton-growing area.

---

[2] For a fuller discussion of this subject see U. S. Department of Agriculture Bulletin 60, The Relation of Cotton Buying to Cotton Growing.

Cotton growers have had to submit to the commercial exactions because in many districts cotton was the only money crop, the only farm product that would bring a cash return for meeting the family needs. In many cases there is no practical alternative to selling the cotton as soon as it is in the bale, if indeed it is not already hypothecated by crop loans, so that it must be turned in at once for what it will bring.

Manufacturers have sometimes been blamed for not cooperating with the growers in their efforts to improve their crop. In many districts the manufacturers have made such efforts, but the inertia of the buying system is so great that the manufacturer as well as the farmer has suffered from the buyer's failure to discriminate between grades of cotton.

GENERAL MEASURES OF IMPROVEMENT

CHANGING THE METHOD OF BUYING COTTON

Manufacturers who require cotton of good quality would seem to have the most direct interest in the improvement of production. Improved varieties are now available with staple an inch or more in length, which usually are as productive as varieties with less than inch staple. The reasons for continuing to produce millions of bales of very short and irregular cotton are not agricultural, but lie in the commercial features of the industry. It is here that the understanding and cooperation of manufacturers are especially needed, in order to extend the production of longer staples. The following statement regarding the effects of marketing on production was included in the writer's address before a meeting of the National Association of Cotton Manufacturers at Atlantic City, N. J., May 24, 1929:

> If the cotton were sold by the farmers in the same way that it is sold to the manufacturers, there would be little difficulty in increasing the production of better fiber. The manufacturer who buys staple cotton expects to pay more for it, but under the existing system the buyer, rather than the producer, takes the premium that the manufacturer pays for superior fiber. The farmer who plants a better variety is expected to sell his longer and more uniform fiber at the same flat price that is paid to other farmers for the short and irregular fiber raised from ordinary gin-run seed. The fiber raised from the good seed may have an intrinsic value several cents per pound above ordinary short cotton, but under the usual conditions there is little encouragement to produce the better fiber, since the farmer who plants seed of a good variety usually is unable to sell his cotton to local buyers at any appreciable advance above the local quotations for the ordinary short cotton. The work of "classing" the cotton, to determine the staple length and character of the fiber in the bales, in order to sort the bales into "even-running" lots, is not done before the cotton is purchased from the farmers, but after the cotton is assembled at the shipping points.
>
> No doubt many of you are familiar with these elementary facts regarding the system of buying the cotton from the farmers at flat prices and with the subsequent operations of "classing out" the bales and making up the com-

> mercial lots at the various shipping points. But it may be that some of you have not reflected upon these features of the industry from the standpoint of the farmer or asked yourselves the direct question how much improved cotton you would plant after you had learned by experience that you would be obliged to sell it at the same flat price that your careless neighbor would get for the product of his gin-run seed. If a yard or a pound of fine cloth had to be sold at the same price as coarse cloth, how many manufacturers would persist in making the fine fabrics?
>
> It is a remarkable feature of the cotton industry, the buying of cotton with so little discrimination of quality in the primary markets. But the system actually exists and serves as a very definite restriction upon the planting of better varieties. Moreover, the system is old and of long standing, so that nobody now alive can be blamed for starting it. Probably it never was started consciously, but grew up gradually with the expansion of the industry.[3]

If the buying system had been planned in the interest of the manufacturers, the quality of the fiber undoubtedly would have been a controlling factor; but the buying system became entirely separate from the manufacturing system. In reality the three fields of activity—production, buying, and manufacturing—have worked as separate systems and not in constructive relations with one another. The buying system unconsciously interferes with the improvement of production and keeps the manufacturers from being supplied with better raw material.

The buying system has worked to its natural result, except in a few districts where the growers have found means of resisting its general tendencies.

ORGANIZING 1-VARIETY COMMUNITIES

Fortunately, there is a simple improvement in production which can aid in bringing about, with no great difficulty, a constructive change in the marketing of cotton. Communities of progressive farmers can avoid many difficulties by the simple expedient of restricting themselves to a single variety of cotton in each district. Adequate stocks of pure seed are maintained in such communities, since only one kind of cotton is brought to the gins or planted in the fields, and the usual mixing and mongrelizing of the seed stocks is prevented.

In a properly organized community all the farmers are supplied with planting seed of the same quality, so that the most important step toward standardizing the crop is taken in advance. Except as the cotton may be damaged by adverse conditions of growing or handling, fiber of uniform character is produced by the entire community, in sufficient bulk to give it a commercial status, thus facilitating cooperative marketing.

It is of no advantage, either to growers or to manufacturers, that the production of cotton should be conducted by the present haphazard methods which prevent the farmer who raises good cotton from getting a price advantage. Community production of one variety is the best preliminary to cooperative marketing and offers a substantial basis for the future progress of the cotton industry. The present system often gives the growers of inferior short staples an unfair advantage over their neighbors who are growing better fiber, but even these short-staple growers might be on a better footing if the community as a whole could improve its production.

---

[3] For an abstract of this paper see Manufacturers' Record, May 30, 1929.

The first communities were organized in the irrigated valleys of the Southwestern States where cotton growing was a new industry and demonstrated their advantages. Special cooperation on the part of the United States Department of Agriculture has been extended to several communities that have undertaken to develop and maintain supplies of pure seed of one variety. A single variety community has existed in the Coachella Valley in southern California since 1920.

The supplies of pure seed developed and maintained in the organized communities have served largely as the basis of production in all the irrigated districts where cotton was grown in western Texas, New Mexico, Arizona, and California, with a further acreage below the Mexican border, in Lower California.

In the eastern Cotton Belt the reaction of a farming community to the payment of premiums for improved fiber is demonstrated by the development of a center of production of long-staple cotton at Hartsville, S. C., through the efforts of D. R. Coker, covering a period of about 30 years. By combining the two functions of breeding the seed and marketing the cotton, a local production of about 40,000 bales of superior staple has been developed, and large quantities of improved seed have been furnished to other parts of the Cotton Belt. In a district that was not considered especially adapted to the production of long staples, the fiber length has been increased from less than an inch until much of the crop is from 1⅛ to 1¼ inches long. Premiums sometimes as high as 50 per cent above the value of short cotton are paid to farmers in the Hartsville district, and the increment of value resulting to this community from these improvements of production and marketing is estimated at $1,000,000 a year.

This development shows the need of responsible intermediaries between the growers and the manufacturers, to meet the requirement of "correct and fair buying at the primary market," which is recognized by Mr. Coker as "the first approach to this question of quality production." The system followed elsewhere of taking improved cotton from the farmers as cheaply as they can be forced to sell it has seemed good business practice for the buyers, but certainly it does not lead to improvement of production. The commercial handling of the good cotton should cost no more than the handling of poor cotton, and may even cost less, since less speculative risk is involved. The former Sea Island crop, the most valuable cotton in the world, was handled at $2 a bale, according to local reports in Charleston and Savannah.

Both seed-supply and marketing problems can be simplified greatly by community organization of production. Assurance of fair prices for the good cotton is fundamental. The farmer must know that he will get the real value of his cotton, or at least the actual market value, and that he will not be exploited by the buyer. The results that have been obtained in a few years in some of the 1-variety communities show that such organization of production opens many new possibilities.

SOME CAUSES OF INFERIOR COTTON

PLANTING POOR SEED

The immediate cause of producing inferior cotton is the planting of poor seed. Most of the cotton crop in the United States is grown from inferior gin-mixed seed that should be sent to the oil mill. Reports issued by the Bureau of Agricultural Economics show that the fiber of nearly 80 per cent of the American cotton crop is less than an inch long, and only 5 per cent attains 1⅛ inches. The producing system as a whole is wasteful in the extreme, since many of the losses could be avoided. Lack of good seed may be considered as a reason why poor seed is planted, but the difficulties of providing the good seed are inherent in the present producing system. The fiber produced from most of the seed now planted is inferior in two respects, in being both short and irregular. The need of uniformity is always admitted, whether for short or for long fiber, but the requirements for maintaining uniformity, as well as for producing good staple, have been neglected.

Superior varieties, which have fiber an inch or more in length and which are not outyielded by the shorter varieties, are now available. No agricultural reason has been found for continuing to plant varieties with less than inch staple in any cotton-growing district of the United States. The practical reasons for planting the varieties with the very short staples is that they may be found more profitable under the present marketing system. Some of the varieties with very short lint give high percentage turnouts at the gin, but commonly do not yield more pounds of lint per acre than do varieties with longer and better fiber. Higher yields are reported in some of the tests with the short, high-turnout varieties, but in other cases the yields are lower than from good-linted varieties. It is recognized that the very long staples, above 1¼ inches, are usually less productive than those with shorter fiber, though even the long-stapled Egyptian cotton often outyields the upland varieties in Arizona.

JUDGING VARIETIES BY TURNOUT AT THE GIN

One of the most frequent and costly errors among cotton growers is to confuse high turnouts at the gin with high production in the field, although the two are essentially distinct. The popular belief in the greater productiveness of very short staples may be explained as a carry-over of the idea from gin turnout to yield.

The gin turnout of fiber is figured as a percentage of the weight of the seed cotton before ginning. Higher turnouts tend to reduce the costs of picking and ginning, which are paid by the hundredweight of seed cotton, but this slight advantage may be more than overcome by lower yields or by inferior quality of the fiber, which in some high-turnout varieties is very poor. The highest turnouts occur with small or light seeds, which are not desirable. The farmer naturally is anxious to have the percentage of lint as high as possible, but it is a mistake to consider the turnout as of exclusive importance.

The tendency to confuse the gin turnout with the yield was recognized and challenged many years ago, as shown by the following statement of R. J. Redding, director of the Georgia Agricultural

Experiment Station, under date of 1893, quoted by J. L. Watkins in King Cotton:

> It is a very prevalent belief that a variety of cotton that will yield the larger proportion of lint to the hundred weight of seed is to be preferred. This belief is based on the assumption that a large yield of lint in proportion to seed indicates a large yield of lint per acre. It is a plausible theory, but experiments show that there is no relation between the yield of lint per hundred pounds of seed cotton and the total yield of lint per acre.

A similar statement is found in Georgia Agricultural Experiment Station Bulletin 20, Fertilizer, Culture and Variety Experiments, Corn and Cotton.

As long as the very short fiber can be sold at the same price as fiber of better quality, the high-turnout varieties have a slight advantage for the farmer in the lower costs of picking and ginning. Unless a market discrimination in favor of better fiber can be established, increased production of better cotton can not be expected. The extra care necessary in regular production of good cotton will not be taken without the inducement of a better price.

Less advantage would be seen in growing the poor varieties if ginning charges were based on the weight of the fiber removed, instead of on the weight of the seed cotton. The picking cost per pound of short-fiber lint may be somewhat lower on account of the lint percentage; but on the other hand the bolls of the high-turnout varieties are rather small, so that picking costs may be higher.

ARGUMENTS REGARDING SHORT STAPLES

It is often taken as a self-evident fact that varieties with very short staples yield larger crops than varieties with good staples. People with this ingrained belief are surprised that anyone should doubt it even enough to make actual yield comparisons in order to determine the facts, and when such comparisons are made and reported the evidence is still regarded as something " against nature."

From a scientific standpoint there is no biological principle to support such an argument—that yields must be greater because the fibers are very short. Stated in this way, the argument leads to an absurdity, and in practice it has encouraged production of cotton varieties having fibers too short to spin, so that the product is no longer suited to normal textile uses, for which it is hardly to be considered as real cotton, but rather as an adulterant.

It could be argued biologically that more lint would be obtained by making the individual fibers longer than by making them shorter. The biological fact is that the very short cottons that give the high turnouts at the gin have small seeds, altering the proportion of lint weight to seed weight. Also much of the material that goes into the bale from some of the short varieties is not really lint fiber, but fuzz fibers which are longer than usual and are ginned off with the lint fibers. It is not without propriety that the product of Half-and-Half and related varieties is often called " buzz-fuzz," since the fuzz fibers in normal varieties are distinct from the lint and are not removed in ginning, but pass with the seeds to the oil mill.

Better varieties than the market has justified are planted in some districts. The Texas big-boll type has not been replaced in Texas by varieties having inferior fiber, although many attempts to do so have been made. This type of cotton has retained its popularity because it is better adapted to growing conditions in that State, yields more, and has larger bolls, also because of its "storm-proof" quality of holding the fiber for long periods in the open bolls instead of allowing it to fall or to string out from the bolls as does that of short-fiber varieties.

PLANTING ON PRICE CONJECTURES

Many farmers do much figuring on price quotations, assuming that varieties or acreages should be changed from year to year to meet supposed alterations in the market demands for longer or shorter staples. Seed dealers often repeat such arguments, or money may be lent freely for planting high-priced cotton in boom periods. Production may thus be made as speculative and hazardous as playing the market on futures, and often the varieties are changed for reasons that are entirely erroneous. In reality, the farmer has no way of knowing what the price of cotton will be several months in the future nor whether high premiums will be paid for longer staples in the following season. Speculative guessing and changing of varieties loses the advantage that might be obtained from a regular production of one kind of cotton.

Very high premiums sometimes may be paid in seasons of scarcity to meet special orders from manufacturers, but they afford no assurance that larger quantities of the longer staple will be called for in the following season. A deficient supply of cotton may restrict the demand instead of increasing it. The danger of having to pay excessive prices naturally tends to discourage manufacturers from making the goods that require a special quality of cotton. Fluctuations in premiums may result from temporary scarcity in particular long-staple districts, and the actual demand in the following season may be met from the usual sources, leaving no market for farmers who have planted extra quantities of the long staples. Even at very low prices, buyers may not be interested in handling small lots of longer fiber from new sources.

A stabilized production of good cotton is the real need and calls for a consistent policy of improvement in the American cotton industry. A large potential demand for better staple undoubtedly exists, and should not be confused with seasonal fluctuations in the premiums quoted for staples of different lengths. The occasional high premiums are much less important than a wider production of cotton of better quality. Regular supplies of good cotton must be available before adequate uses can develop. A gradual adjustment may be expected, not a sudden demand for a greatly increased production of longer staples. The premiums may go down if more long cotton is in sight than the mills are ready to use, but the low prices may be followed in turn by a gradually increased demand. Manufacturers are agreed that much larger quantities of good fiber would be used if it were known that the needed supplies would be available at reasonable prices.

Community production of one variety of cotton leads toward a gradual, sustained improvement in the quality of the fiber. Districts that establish a regular production of good fiber may be sure that better prices can thus be obtained over long periods of time, than by changing and mixing the varieties. The kind of cotton that the community can plant to the best advantage should be determined with careful consideration of the best indications of supply and demand through a term of several years, and the farmers in organized communities should be advised to follow regular courses from year to year regarding the land to be chosen, the cultural procedures, and the handling and marketing of the crop.

CHANGING THE SEED

One of the more serious of the popular errors in cotton production is the belief that it is necessary to change the seed, which usually means changing the variety. Even in districts where good stocks of seed of a superior variety have been established, outbreaks of the seed-changing mania are likely to occur after any unfavorable season, and noticeably inferior varieties may be substituted on account of the unreasoning pressure for change. Many farmers are so thoroughly grounded in their belief in the necessity of this change that they take it as a duty to be performed regularly every second or third year. Numerous infractions of State quarantine laws have been committed in the Western States by people who took the trouble and risk of obtaining from a distance seed very inferior to that they already had.

The more varieties brought into a community, the more mixing goes on at the public gins and the more crossing in the fields. The more the seed is changed, the more rapidly the seed stocks run out, so that the seed-change idea actually produces the effect that it is supposed to prevent. In reality, there is no basis of fact for any general practice of seed changing. Except as better stocks can be obtained to replace worse stocks, there is no occasion to change. Getting a better seed stock does not mean that the variety must be changed. A livestock raiser buys a superior bull of the same breed, not of some other breed, to improve his herd.

Most of the changes are made without any definite information that any advantage may be expected. The number of new varieties is so great that not all of them can be tested adequately in the different sections of the Cotton Belt, and most of them have passed their popularity and have been discarded in the time it would take for such tests to be carried through properly and under a range of seasonal conditions. All such tests show that the yield relations of the varieties differ with the seasons. A variety very prolific in a good season may shed more and yield less in a bad season than a variety less prolific under other conditions.

The seed sellers defend their policy on the ground that the public expects novelties and will pay high prices only for new kinds of seed, which it is their business to supply. But this supposed need comes from the education which for many years the seed dealers have been giving the public. If the cotton growers generally were correctly informed they would be more willing to pay for really select stocks of good and well-known varieties and they would demand fewer untried novelties. It is scarcely ethical to misinform the public in these matters and no practical purpose is served by catering to those already misinformed.

Several cotton varieties such as Trice, Columbia, Durango, Meade, Lone Star, and Acala, have been developed by the United States Department of Agriculture and used extensively but not so extensively as their qualities warrant. State institutions and private breeders have developed and distributed seed of these varieties, but without the extensive advertising that many of the private stocks have received.

If the precautions needed to maintain good stocks of seed are applied continuously, the stocks can be maintained over long periods of years. No matter how uniform a seed stock may be made by careful selection, it does not remain uniform unless the selection is continued, and the stock is isolated from other varieties to prevent crossing. Varieties do deteriorate if these precautions are neglected, but no advantage is to be expected merely from changing the seed. If new seed is to be of any value it must come, not from a place where the seed-changing theory has been followed, but from a locality where one variety has been grown, isolated, and selected for a number of years. To make permanent progress in improvement of varieties and seed stocks it is necessary to get away from the idea that changing the seed has any virtue in itself.

PLANTING TOO MANY VARIETIES

The number of cotton varieties is out of all proportion to practical needs. Names of about 1,200 have been recorded in the United States, and of these about 400 have been added in the last decade, indicating that two or three dozen new varieties appear every year. A total of 438 names was reported through a questionnaire in 1924, but probably that list was far from complete. From one of the cotton States 140 names of varieties were reported. Some were found to be different names for the same variety, but even with such deductions there probably are between 200 and 300 different varieties, most of which are superfluous. Probably a dozen varieties would serve all the purposes of production better than the existing multiplicity.

Certain varieties of cotton have been shown by experiment to have a very wide range of adaptability to different conditions of growth. Several series of varieties represented by the same stocks of seed have been planted during a period of several years, in widely separated localities. A number of varieties, such as Mebane, Lone Star, Durango, and Acala, that were bred or acclimatized in Texas, have grown normally and produced high yields under many different conditions across the entire Cotton Belt, from southern Virginia, North Carolina, and South Carolina, to the irrigated valleys of New Mexico, Arizona, and California. The Durango cotton was very prolific in the Imperial Valley of California and also produced yields of a bale to the acre near Norfolk, Va.

Endless variations can be found in cotton plants, and breeding new varieties would be relatively easy if any practical object were served by multiplicity of kinds. But after a new stock is bred a much more difficult task is encountered: that of determining whether it is superior or inferior to the parent type.

Many new varieties are put out merely to meet the demands of persons who believe that the seed should be changed frequently, and who, without reasonable precaution, frequently buy seed that has never been tested and for which no assurance of value can be given. The unsupported statements of seed sellers are often credited, even by farmers who in other matters may be considered very cautious and intelligent. The usual reason that the farmer gives in such cases is that he decided to try the seed, though as a rule he had no idea of making any real test. The new seed may be sown with other cotton or in a separate field, from the success or failure of which the farmer may form a favorable or an unfavorable opinion, although the result usually depends much more upon the land or the season than upon any real determination of value.

CONFUSION IN FARM PRACTICE

The needless multiplicity of varieties not only is wasteful and injurious from the standpoint of seed mixing but tends to carelessness in cultural operations. The effects of cultural and seasonal conditions are generally confused with differences between varieties. A farmer who is disappointed with his crop resolves at once to change his seed and does so instead of recognizing that he may have chosen the wrong land or applied wrong methods in growing his crop.

Much greater interest and progress in the improvement of cultural methods are evident in communities that have adopted the plan of growing only one variety. Farmers in such communities, knowing that they have planted the same seed as their neighbors, are aware that other factors are responsible for differences in the behavior of the plants or in the yields and begin to profit by such knowledge. Cotton farming is not on a scientific basis until the confusion regarding varieties is cleared up, so that differences due to growing conditions are not mistaken for varietal characters.

FAILURE TO TEST VARIETIES

Repeated comparisons of cotton varieties are necessary in order to avoid being misled by irregular conditions. Even if the same kind of cotton is planted in uniform soil, adjacent rows often show marked differences in yields, which would be entirely misleading if the rows represented different varieties.

Under the present method of testing cotton varieties, comparisons are made between only two varieties at a time, the two kinds being planted in alternating 4-row blocks, usually three 4-row blocks of one variety and four of the other, and two guard rows added to the outside blocks. The rows usually are 300 feet or more in length, and at picking time the field is divided across, normally into three sections of 100 feet each, and each section of each row is picked, weighed, and recorded separately. With the yields of the different row sections thus recorded, it is possible to judge the regularity of the conditions and to decide whether consistent differences between the varieties have been shown.

Each of these tests affords numerous direct comparisons between the two varieties or methods that are included. The value of a particular test is determined by seeing whether the behavior of the varieties was consistent, rather than from general totals or average yields, which sometimes are misleading. If consistent differences are not shown in the several comparisons that are made, the only conclusion to draw is that the conditions were too irregular or that the yields were too nearly alike for definite differences to be determined under the conditions of the experiment.

Only a few varieties have been carefully tested in this manner, because the need of making such tests was not understood in the past. General recognition of that need would, of course, seriously interfere with the marketing of any such numbers of novelties as now are brought forward annually by the seed trade. Although few farmers are in position to undertake such thorough variety tests for themselves, the nature of the tests should be known more generally because they are the only means of protecting individuals or communities against ill-advised changes of varieties or seed stocks. An eloquent and irresponsible seed seller can often do considerable damage where a community leader or a wealthy landowner proves susceptible. Cases are known where seed stocks carefully bred and tested for years have been summarily replaced by untried novelties without even a subsequent comparison of the stocks to determine whether any advantage had been gained.

Any stock that is developed from a productive plant is likely to be productive, but not necessarily more so than the parent stock. The productiveness of the selected individual may have been accidental and not inherited or transmitted. Many such selections prove to be less productive, and very few are found to be more productive, when they are increased as progenies and carefully compared with the parent stock. Selection must be maintained, in order to keep up the yields of productive varieties; but claims of higher yields for new kinds of cotton are not to be accepted without the evidence which can be provided only by thorough tests.

MISLEADING CLAIMS FOR VARIETIES

Many misleading claims are used to assist the sale of seed of new varieties that have no real reason for being offered to the public, and the little attention given by the growers to the characters and behavior of the plants in the field is shown by the many forms of obvious misinformation that find credence. High lint percentages are often claimed as an invariable feature, whereas the same variety will show a wide range of percentages when grown in different localities or even in the same place.

The early and late season bolls produced on the same plant may show notable differences in percentage of lint, as well as in the length and strength of the lint, if the plants have been exposed to stress conditions. Even under the best conditions, no kind of cotton is entirely uniform in fiber length, as short fibers (substaple) are always to be found among the full-length fibers.

Merely by the advertising of a variety as five lock, farmers are led to believe that this is a constant character and that all of the cottons that produce 4-lock bolls are mixed and inferior. In reality no kind of cotton has an invariable number of locks in the bolls. Some of the upland varieties have higher proportions of 5-lock bolls than others, but in any variety the proportions are found to vary with the conditions.

Many so-called "cluster cottons," with very short-jointed fruiting branches, have been advertised and sold as very productive new varieties. They appear very fruitful because the cotton shows in large masses where the bolls are crowded together, and sometimes they produce large crops under favorable conditions. None of the cluster cottons has attained more than temporary popularity, as the yields are very irregular, and many of the plants are entirely sterile under unfavorable conditions. A detailed study has shown the cluster habit of growth to be a result of abnormalities in the formation of the branches. This explains the tendency to sterility, which apparently is a general feature of the cluster cottons.

PROPAGATING HYBRIDS

The idea of crossing different varieties of cotton in order to develop superior new kinds is met with occasionally, though many such experiments have been made without producing results of practical value. Hybrids of plants that can be propagated by buds or cuttings often are valuable, but the biological problems are different with plants that have to be grown from seed. Large numbers of crosses of upland varieties with Sea Island and Egyptian cottons have been made and carried through many generations without the breeders being able to establish uniform strains. The first-generation plants are very vigorous and productive, while the second and later generations show many degenerate and infertile individuals and some that are completely sterile.

PLANTING UNSUITABLE LAND

For lack of other crops that can be sold for cash or serve as security for loans, many farmers are compelled to plant cotton on land that affords little prospect of a profitable return. The crop-loan system often allows the dependent farmer no alternative, and thousands of poor-land farmers are producing cotton from year to year for a bare living. More diversified farming and smaller acreages in cotton are strongly advised in some districts, and more care generally should be given to avoiding land that is too poor or too rich, too wet or too dry, for cotton to yield well. Very rich land in some districts has the serious disadvantage that luxuriant, overgrown cotton requires a longer season to mature its crop, and hence is more exposed to weevil injury and to frost damage in short seasons. Wet land remains cold and makes for a slow growth in the spring and late opening of the bolls in the fall.

Rotation, green manuring, terracing, or other precautions to maintain or improve the soil must be considered long in advance, and land that is not in good condition should be avoided. Usually the effort and expense required in preparing the soil and planting and cultivating cotton on unsuitable land are the same as for raising a good crop on suitable land.

PLANTING TOO EARLY

Losses are often invited by planting too early. Farmers are urged to plant early to avoid weevil injury, but even in this matter discretion is desirable. No advantage is gained by crowding the season.

The farmer who plants very early knows that he runs the risk of having to plant again, but the cost of replanting is not the greatest loss that can occur. The young seedlings may be stunted by long periods of cold weather, may lose time in recovering, and some of the plants may be permanently dwarfed. The weakened seedlings may die successively until the stand is badly reduced but too late for replanting to be undertaken. In many instances later plantings have been more productive than early plantings, including formal side-by-side comparisons in weevil-infested districts.

The greatest protection against weevil injury undoubtedly could be obtained in communities or districts that planted all their cotton as nearly as possible on the same date, chosen with reference to the best growth and fruiting of the plants. There is no apparent reason for choosing an extra early date. Under such an arrangement there would be no need to take the hazards of extra early planting. It is true that relatively few communities in the weevil-infested regions have developed forms of organization that would bring about practically simultaneous planting. More extensive cooperative organization among cotton growers is expected in the future, and greater protection against the boll weevil is one of the purposes that such organizations may serve.

The need of caution and the advantages of simultaneous planting in organized communities are recognized in the recommendations of the Cotton Council,[4] as follows:

> Delay planting until danger from frosts and cold is past and the soil is warm enough to give prompt germination and vigorous early growth. Plant 1 bushel or more seed per acre. A perfect stand is immensely important. As nearly as practicable all cotton in the same community should be planted at the same time and in the same variety.

THINNING TOO EARLY

Cotton often is chopped or thinned too early, to the detriment of the young plants or the loss of a stand. No advantage has been shown in chopping before the plants are at least 5 or 6 inches tall. If any adverse conditions such as cold winds or blowing sands are encountered in the early stages of growth, the plants are more protected and make better growth if they remain in a close stand than if they are exposed by early thinning. Rather late thinning, after the plants are 8 or 10 inches high, may be found desirable where cotton grows very rank and produces too many vegetative branches. If the plants are left close in the rows there is less occasion for thinning to be deferred.

SPACING TOO WIDE

The spacing problems have had close attention since the arrival of the boll weevil, and a general change to closer spacing has taken place, though millions of acres still are thinned too wide. Most of the State experiment stations advise close spacing, with the hills

---

[4] The Cotton Council was organized in the U. S. Department of Agriculture in 1922, under the general direction of the Assistant Secretary of Agriculture, for the purpose of coordinating the department's activities in relation to cotton and assisting the State colleges and experiment stations in a comprehensive and coordinated program of improvement in cotton production in the United States.

10 to 14 inches apart and two or three plants in a hill—in some States even four or five plants. The usual advice is to leave the hills a hoe width apart, which brings the centers of the hills about a foot apart. Previous to the arrival of the boll weevil the farmers were advised to space cotton much wider, 15 to 20 inches or even 2 feet apart in the rows, in order to allow a full development of the individual plants.

At first it was supposed that the breeding of the boll weevil could be restricted by spacing the plants still wider apart, but later it was found that the branching habits of the plants could be controlled by closer spacing, which rendered wide planting unnecessary. The spacing problems can not be clearly understood until it is recognized that the cotton plant has two kinds of branches which are entirely distinct in structure and function. The joints at the base of the main stalk of the plant produce vegetative branches which function as secondary stalks, while joints farther up the main stalk produce fruiting branches.

The vegetative branches, or secondary stalks, may grow nearly as tall as the primary stalk, and if many such branches are produced they may fill all the space between the rows. In fields of large, spreading plants the ground is completely shaded, a condition that invites the greatest damage from the boll weevil. The opposite condition, with the greatest possible surface of the soil exposed to the heat of the sun, is needed for protection against the weevil. The summer generations of weevils develop in the infested flower buds or squares, which fall off and lie on the ground, being shed a few days after they are punctured by the weevils. Thorough drying of these fallen buds by the heat of the sun is fatal to great numbers of the weevil larvae.

Keeping the lanes open between the cotton rows is desirable, not only to kill as many of the weevil larvae as possible but for several other reasons. Even where there are no boll weevils it may be important to have the crop develop as rapidly as possible, to meet short-season conditions.

Leaving the plants close together in the rows has the effect of suppressing the vegetative branches. The number of plants is increased, but their size is reduced, not necessarily in height, but through the lack of vegetative branches, or side stalks, as they are sometimes called, and the individual plant is restricted to the single main stalk. Keeping the lanes open allows the row space to be used more intensively, and the larger number of plants more than compensates for the restriction in size. More flowers are produced and more bolls are set early in the season on rows of close-spaced plants than on equal rows of larger, wide-spaced plants. The development of fruit on the vegetative branches, or side-stalks, necessarily is later than on the main stalk. and the effect of close spacing is to substitute main stalks for side stalks.

If the cotton grows rank and the plants have many side stalks, the lower fruiting branches are likely to be smothered, or if early bolls are developed they are likely to be rotted or mildewed under the heavy canopy of foliage that forms a continuous covering in fields of rank cotton. Under this condition there is little prospect of harvesting an early crop. Even where there are no boll-weevils, fields that are smothered under heavy foliage may produce little or no cotton, as the crop is borne late in the season and may not mature before frost. Where weevils are present in rank-growing cotton the setting of late bolls is out of the question, and the crop is a complete failure.

Closer spacing of the plants tends to restrict the rank growth which is an undesirable feature in late-planted cotton. When the seedlings develop in hot weather the plants take a different form, with more vegetative branches and less tendency to set fruit promptly. Hence late-planted cotton especially needs to stand close in the rows, to restrict the size of the plants.

The spacing problem is obscured by some writers who do not recognize the facts of the structure and behavior of the plants but who argue on false premises. It may seem reasonable to suppose that spacing the plants farther apart would be the practical way of keeping the fields more open to the sun, but when the formation of the vegetative branches is understood, the apparently logical conclusion gives way to the facts about the method of controlling the branches.

The following summarized advice to farmers regarding the spacing of cotton was issued by the Georgia Agricultural Experiment Station in Press Bulletin 311, Cotton Chopping Facts for Georgia:

> Georgia cotton growers are losing thousands of dollars every year because of poor stands or too few plants per acre. * * * The old pre-boll-weevil practice of cutting out all but one or two plants in the hill and leaving from 2 to 3 feet of space between plants is not recommended for 1930. * * *
>
> *Unthinned or nonchopped cotton.*—During some seasons cotton left just as it comes up will yield as much as spaced cotton. Where less than 1½ bushels of high-germinating seed are used on each acre enough thinning can be done by running a drag harrow across the rows. In the northern part of the State and elsewhere where a poor stand requires planting over it is often best to leave all the plants except those that must be plowed up in removing weeds and grass. During 1929 on the station farm cotton planted over May 15 and left unthinned produced as much as spaced cotton. Only about one-half as much time is required to merely remove weeds and grass as it takes to thin the plants to two per hill with hills one hoe width apart.
>
> *Hoe-blocked cotton.*—Where the plants are very thick in the drill it is usually advisable to thin by removing all the plants in every other hoe width of the row; that is, the plants in one hoe width are left and the next hoe width are cut out. This operation requires very little time as compared with the common tedious method of chopping. Even if a half-dozen plants are left in a hoe width, tests have shown that the yield will justify this labor-saving practice. Hoe blocking is ample thinning for the average field.
>
> *Two plants, one hoe width.*—Cotton farmers are not justified in having less than two plants to each hill and hills more than one hoe width or about 1 foot apart. Fewer stalks than this may look better in the field, but actual trials favor closer spacing.

PICKING TOO LATE

Leaving the cotton too long in the fields before picking is a cause of extensive damage to the crop. It is customary to pick cotton more promptly in the eastern districts of the Cotton Belt where rains are more frequent and often do serious damage to the fiber. Formerly it was customary to make three or even four pickings, but with increased costs of labor the tendency has been toward fewer pickings.

Where no rain is expected, in the drier short-season districts, the cotton often is left in the fields until the end of the season, and only a single picking is made. This is considered to be one of the advantages of production in the dry regions, but there is always a risk of rainy weather that will soil and stain the cotton. Even if no rain falls, cotton left in the fields for two or three months after the bolls are open undoubtedly is affected to some extent by exposure to the sunlight and the dust storms. A little rain, that might do little or no damage to clean cotton, may be definitely injurious following a dust storm, to say nothing of the cotton that is whipped out and lost, as shown in the title-page illustration. Some of the storm-proof upland varieties hold the seed cotton remarkably well in open bolls for long periods, but too much reliance should not be placed on this fact to justify late picking.

The late-picked cotton generally is considered inferior to the early crop and shows a different character, often described as "soft." Differences of behavior in ginning and baling of early-picked and late-picked cotton are recognized, especially in the irrigated valleys where some of the cotton is left in the fields for the longest periods. The late-season fiber is more bulky in relation to its weight than is the early-season fiber, so that late-season bales often fall below 500 pounds, while early-season bales often run above 500 pounds. No doubt some physical difference or change in the character of the cotton is the reason for the greater bulk of the material later in the season.[5]

BREEDING WEEVILS IN THE FALL

Millions of acres of cotton land breed weevils in the fall, where the plants are left in the fields after the crop is harvested. The northern areas usually are reached by frost before the cotton is picked, or even before all of the bolls are open, but in the long-season southern districts the weevils are given an entirely unnecessary opportunity to breed late in the fall. Even as far north as Charleston, S. C., two or three months may elapse between the last picking of the cotton and the first killing frost. In the more southern areas frost may not come until Christmas, or in parts of Florida and Texas the entire winter may pass with little or no frost. With the weevil present, there is no possibility of a late crop being matured in any of the humid districts, but the plants continue to grow, and the weevils continue to breed in the flower buds, so that in the late season the weevil population is recruited to pass the winter.

The need of clearing the fields promptly at the end of the picking season and thus putting a stop to the breeding of the weevils has been recognized almost from the first days of the weevil invasion as "the most important step in the control of the boll weevil," though generally this practice is followed only in a desultory way. To obtain the full advantage, entire communities need to be organized, so that all of the fields can be cleared at an early date. W. D. Hunter said:

> Concerted action in fall destruction is, of course, desirable. The greatest benefit will result only when whole communities adopt the method. But no planter should hesitate on account of the indifference of his neighbors.

Usually it is found on local inquiry that a few of the more progressive farmers clear their fields early in the season, or that this was done in former years. Such efforts, however, are not likely to continue if the progressive farmer is surrounded by careless neighbors, since the advantage from clearing the fields is not shown in a definite way. The fields that have been cleared may appear to have as many boll weevils the following season as those that are not cleared, so that arguments are not conclusive, and early clearing is not established as a general practice.

---

[5] This difference was pointed out in a communication from S. H. Hastings.

The advantage to be gained by concerted action is illustrated by natural occurrences. In Texas and Oklahoma dry weather may prevent the breeding of weevils in the autumn months. If the drought is sufficiently severe to stop the growth of the cotton plants, large areas may be free of weevils the following season. The weevils may be practically destroyed by an invasion of leaf worms, which eat all the leaves and tender growth of the cotton, including the flower buds and young bolls where the weevil larvae can develop, so that no late-season weevils are bred. All the cotton fields in an entire district may be cleared by the leaf worms, and in such cases an absence of weevils is noted the following season.

In the lower Rio Grande Valley, in southern Texas, it is customary to clear the cotton fields in August, in order to plant winter vegetables. The boll weevil is less of a menace in districts where the early clearing of the fields is more generally practiced.

When the weevils are allowed to continue breeding in the fall, there are more of them to pass the winter and the late-season broods go into winter quarters still young and vigorous and with much greater chances of survival. The Bureau of Entomology, in a series of experiments, has shown a much greater mortality among weevils deprived of food early in the fall.

If, by agreement in a community, all fields are cleared by the middle of October, only a remnant of the weevil population might survive to go into winter quarters and fewer yet would be able to emerge and attack the cotton in the spring. Such concerted action against the weevils in the fall might be especially important in the warmer districts which have a longer period between the cotton harvest and the first killing frost.

To be really effective such action must be taken by all growers, and it is difficult to bring this about. Even where most of the farmers are ready to make a concerted movement a few irresponsible individuals may discourage or prevent a general effort. It may not be feasible to organize a community for weevil protection alone, but such protection is one of several benefits possible through community organization. Undoubtedly it is only lack of knowledge of the facts on the part of the farming public that prevents such measures being taken.

MIXING SEED AT PUBLIC GINS

While the modern equipment of the public cotton gin is mechanically superior to the small plantation gins used before the Civil War, the mechanical development in ginning has brought new problems into the cotton industry. Using their own plantation gins, planters who practiced seed selection could keep their own seed stocks unmixed, but the present-day public gin mixes the seed of an entire community.

Past efforts to improve the quality of ginning have been handicapped by lack of scientific information and by the number and complexity of factors in both the seed cotton and the ginning process. Scientific study of ginning problems has been impeded by lack of adequate facilities for controlling ginning conditions and by lack of suitable methods of measuring the effect upon the ginned lint of variations in the seed cotton and in the ginning process. The Bureau of Agricultural Engineering has established at Stoneville, Miss., a cotton-ginning laboratory designed and equipped for experimental work, and important developments in fiber analysis have been made in connection with the cotton standardization work carried on by the Bureau of Agricultural Economics.

In the absence of such laboratory facilities, manufacturers have placed their equipment in the field to be tried out and have relied upon cotton classing for indications of the commercial characteristics of the resulting product. Progress which they have made under these conditions is a tribute to their judgment and ingenuity.

The construction and operation of the gin machinery are such that extensive mixing of seed is very difficult to prevent under the usual conditions of production with one variety of cotton often following another at the gin. Each wagon load of cotton lined up at a public gin may contain a different variety. (Fig. 1.) Under the usual methods of operation, from 1 to 2 bushels of seed remain in the seed roll of each gin stand, to be mixed with the seed of the next customer. Careful tests have been made to determine the extent of this mixing. The seed rolls were taken out and dyed red so that the seed that had been left in the gin could be definitely identified in the subsequent operation. (Fig. 2.) A farmer who takes one bale to the gin receives an admixture of about 26 per cent of seed from the cotton of his predecessor. Even in the second bale an admixture of 1.6 per cent is present.

Though still generally disregarded, this condition undoubtedly is responsible for the general mixing and mongrelizing of seed stocks. With plants of different kinds in the fields, the character of the fiber is essentially uneven. The general absence of precautions against mixing means that practical quantities of good seed are to be had only in single variety communities.

The conditions of community production are sometimes approached without any formal organization of the farmers, through the influence of a prominent seed grower. At Lockhart, Tex., the late Alexander Mebane developed the Triumph variety, later called Mebane, and maintained a stock of pure seed for many years. But no widespread or permanent improvement is to be expected from individual efforts without community cooperation. Precautions can be taken to avoid gin mixing with small quantities of seed, but are not feasible on a large scale. It is more practicable to restrict the production in a community to one variety than to keep the seed stocks of different varieties separate, which has not been done effectively on a practical scale, though often attempted.

Even gin equipment that would avoid some or all of the present mixing of seed at the gin would not completely solve the problem of maintaining uniform seed stocks. Cross-pollination would still go on as long as different kinds of cotton were planted in adjacent fields, or even in the same neighborhood. The cotton pollen is not blown by the wind but the honeybees are known to range commonly for a mile or more from their hives, to say nothing of the wild bees, wasps, and other insects that in some districts visit the cotton flowers in large numbers. The only effective way to prevent the mixing of seed at public gins and in the field is to have separate communities that grow only one variety of cotton.

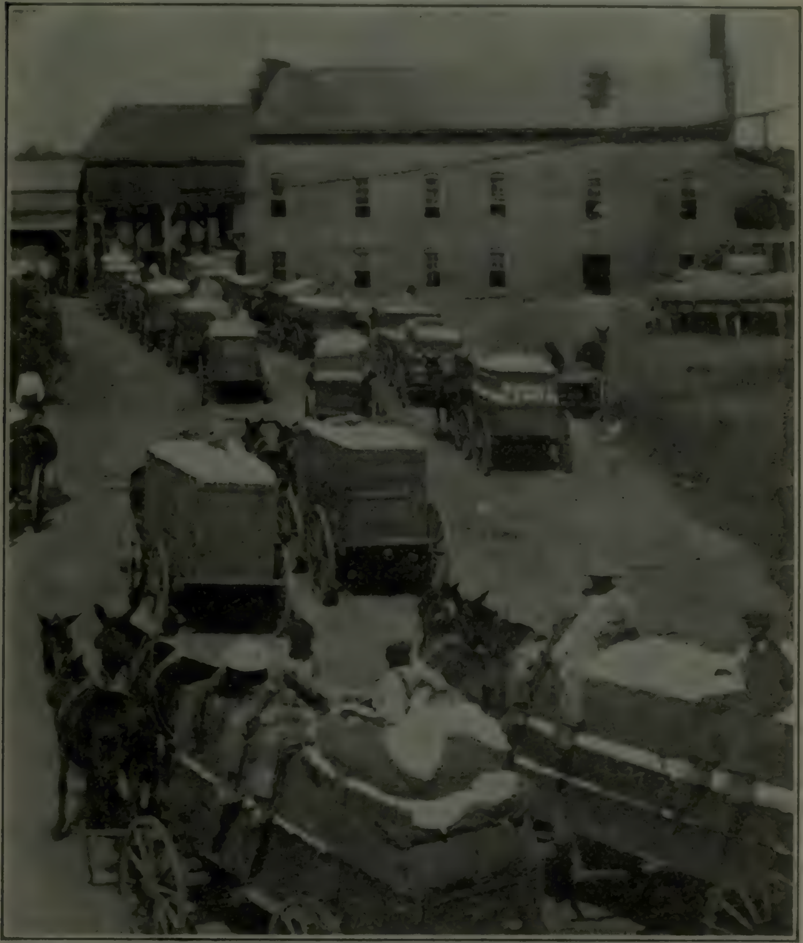


FIGURE 1.—Farmers waiting at a public gin. Each wagon may contain a different kind of cotton

GINNING TOO CLOSE

Cotton is commonly ginned too close, in order to take off short fiber and fuzz from the seed coat, and thus to increase the weight of the bale. Too close ginning is one of the consequences of indiscriminate buying. With the buyers paying the same price for all the cotton, the farmer naturally wishes to have his bales weigh as much as possible, and insists that the ginner shall give him a high turnout.

If cotton were sold on its merits in the primary markets the farmers would soon recognize that its quality is impaired by close ginning. They would understand that high turnouts are obtained

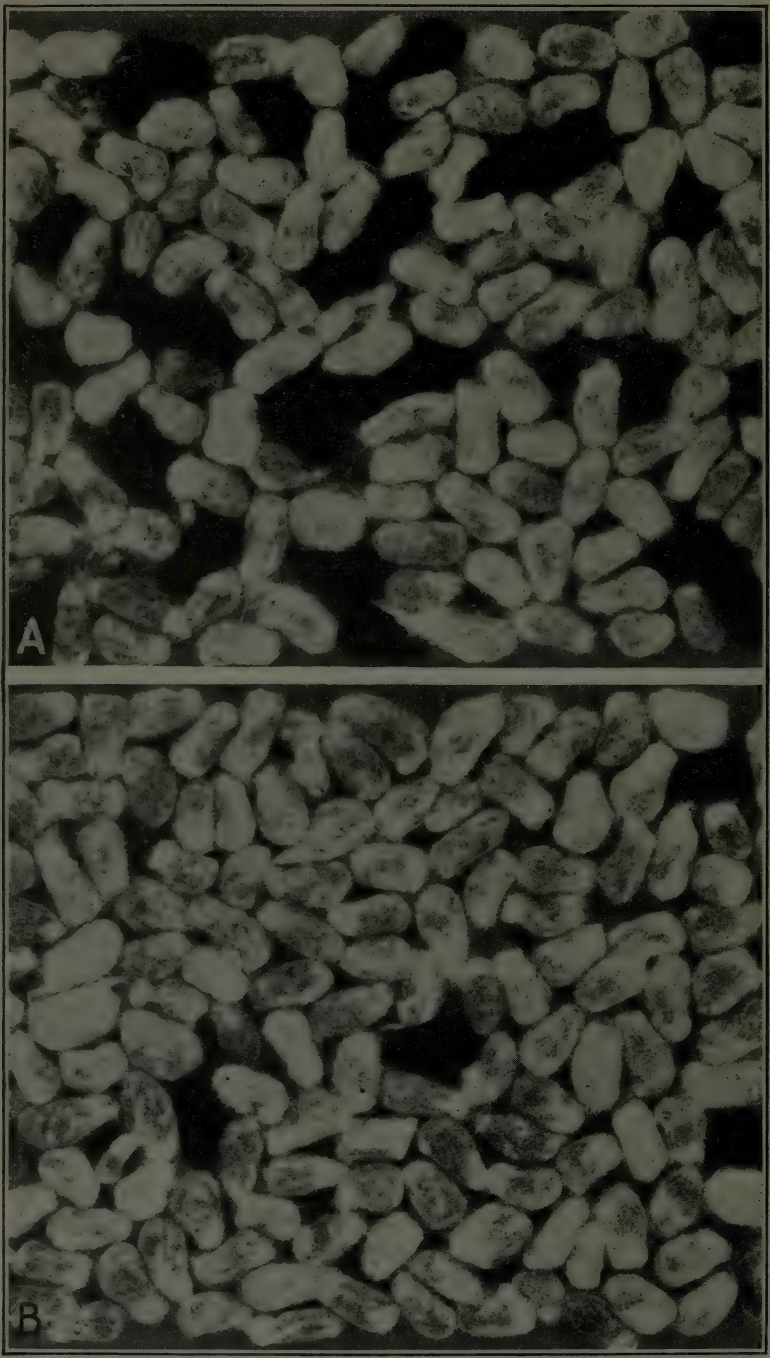


FIGURE 2.—An experiment to determine the extent of seed mixing at public gins. The seed roll was taken out, dyed red, dried, and replaced, and ginning resumed. The frequency of red seeds after 10 minutes is shown in A, and after 20 minutes in B. Even in the ginning of the second and third bales red seeds were found

by including in the cotton lint a part of the fuzzy covering of the seed consisting of very short fibers, of no use for spinning, and constituting in reality only an adulterant in the bales. Indeed, the fuzz and short fibers are worse than useless to the manufacturer, since they not only constitute "waste" at the mills, but also require costly mill processes for their removal.

Usually the turnout, or percentage of bale weight to seed cotton, is the only item of definite information that the farmer obtains regarding his crop and the only feature in which he takes an active interest. If not satisfied with the turnout received at one gin, the farmer will go to another, or will change his seed, in the belief that the variety has run out.

As long as the custom holds of buying all cotton at the same price in the local markets, the ginners will continue to prepare the fuzz-laden, high-turnout bales that the farmers think they must have in order to get the full return for their cotton. The flat-price system invites adulteration by the farmer, both by growing inferior cotton and by having it ginned badly, with the maximum of "buzz-fuzz" and seed fragments included to increase the weight of the bales. The only improvement to be expected is through change in the buying system, so that higher prices can be paid for bales that are not adulterated with linters.

Close ginning is seen to be definitely undesirable with cottons of good quality and length of staple, in markets where good cotton is recognized and bought at a premium above the short staples. Such cotton loses in grade and value from the presence of fuzz and neps. The farmers then ask to have their cotton ginned "for staple" instead of "for turnout." Gins in some districts are equipped for giving the farmer what he wants. If the cotton is ginned for staple, the linters can be left out, while farmers who order turnout are served with more linters and trash in their bales. Buyers of good fiber avoid the high-turnout bales, which they know have been charged at the gin with linters and other waste. By close ginning, 10 pounds of linters may be added to a bale, and at 20 cents a pound this would bring the farmer $2. But if the addition of the linters keeps the bale from being sold for 21 or 22 cents a pound, so that a net loss of from $3 to $8 per bale is involved, close ginning no longer appears as an advantage to the farmer, and he is willing to change his policy. In communities where good cotton is being grown, careful ginning is a matter of great importance in preparing the crop for market.

Grading as well as classing has been arbitrary or casual in primary markets until recent years. Trashy or stained cotton has been penalized, but higher grades are seldom recognized in the primary markets. Only an increased weight of the bale was likely to bring a higher return to the farmer.

GINNING TOO WET OR TOO DRY

Putting wet cotton through the gins is another cause of loss, induced by the lack of discrimination of quality in the primary markets. The ginners generally are aware of the injury that is done by operating on wet cotton, but they are unable to refuse service, as this may drive their customers to other gins. A general need exists for artificial drying facilities, and this problem is receiving attention in the Bureau of Agricultural Engineering.

Cotton ginned while damp is often described as "gin cut" and is recognized by the dense flakes sometimes called "naps" or "locks," formed by the wet fibers packing around the saw teeth. These naps are distinct from the neps that are increased by close ginning.

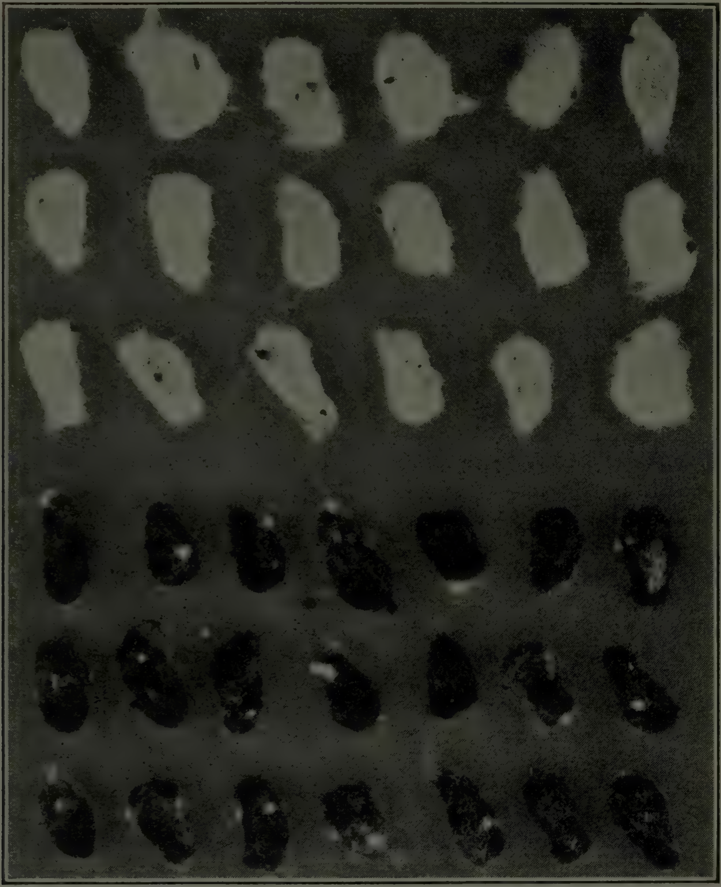


FIGURE 3.—Production of neps in ginning. Ginned seeds were dyed red and placed in the seed roll with undyed cotton. After ginning had been continued, many red neps appeared, which undoubtedly were formed from the fuzz of the dyed seeds. Some of the red neps are shown in the photograph as black spots against the white fuzz of the uncolored seeds on white seeds, and many of the usual white neps are shown on the colored seeds

In the more humid sections of the Cotton Belt it was customary to dry and store the cotton before ginning, so that a uniform condition of moisture was reached. The old plantation gins in the Southeastern States had drying floors for spreading out the cotton, and public gins were sometimes provided with storage bins, but such precautions are practically unknown in the drier sections of Texas and other Southwestern States. Even in these districts gins should have facilities for artificial drying, because rainy weather sometimes does serious damage.

Cotton that is very dry may show many neps, if ginned at very high rate of feed, especially when a high saw speed is used. Though the fiber may not be injured, the commercial value may be impaired if too much fuzz comes off with the lint. It appears that when the seeds are very dry and brittle more small particles of the seed coats are chipped out by the saw teeth. The particles of seed skin with a few of the fuzz fibers attached are the neps which are most objectionable to the spinners, as they are most difficult to separate. An experiment made by J. S. Townsend at the United States Cotton Field Station, Shafter, Calif., demonstrates the formation of neps by separation of small tangles of fuzz from the seeds in ginning. (Fig. 3.) The neps and loose fuzz apparently are most abundant in cotton that has been checked by drought, so that many of the seeds are aborted and shriveled. Observations reported by Mr. Townsend indicate that drying and shrinkage of the seeds may loosen the seed coats so that more of the fuzz and neps are detached in the ginning process.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	ARTHUR M. HYDE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	W. G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel and Business Administration.	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Solicitor	E. L. MARSHALL.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	R. Y. STUART, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Plant Quarantine and Control Administration	LEE A. STRONG, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*

U. S. GOVERNMENT PRINTING OFFICE: 1932

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1687

REMOVING SPRAY RESIDUE FROM APPLES AND PEARS

BEFORE
AFTER

PRESENT METHODS of spraying for the control of the codling moth in apples and pears in many sections of the United States frequently result in an arsenical residue on the fruit in excess of the world tolerance of one one-hundredth grain arsenic trioxide per pound of fruit. Oil or lime-sulphur in the spray usually makes it more difficult to remove this residue, while lime in the spray facilitates removal.

Dry-cleaning methods generally can not be depended upon to remove consistently over 30 per cent of the residue from apples. They also involve danger of mechanical injury to the fruit, especially pears. Cloths or brushes used in dry cleaning should be changed frequently.

The use of chemical solvents has been found the most satisfactory method of removing arsenical residue. Commercial hydrochloric acid at the rate of 1 to 4 gallons per 100 gallons of water has generally proved most satisfactory. Exposing the fruit to the acid wash for one-half minute to five minutes, depending upon the type of equipment used, is recommended. A method of testing the acid strength is given. It is desirable to change the acid solution daily or after 1,000 bushels of fruit has been washed. Concentrated hydrochloric acid is very corrosive and must be handled with care.

Alkaline solvents are used in some cases, usually at a temperature of 100° F. or above. Washing fruit with these, however, subjects it to greater danger of injury than washing it with hydrochloric acid.

The efficiency of the acid solution is increased by warming it to a temperature of 80° to 100° F. With fruit that is especially difficult to clean, a special type of kerosene emulsion added to the acid solution gives good results. The addition of 1 to 3 per cent of salt also increases the efficiency of the acid solution.

Thorough rinsing and careful handling of the fruit and systematic changing of the acid solution are essential in safeguarding the fruit against injury. It is not necessary to dry the fruit, although removing some of the excess moisture facilitates packing when fruit is wrapped.

Two simple types of homemade washing equipment are described. The cost of washing varies from 1 to 5 cents a bushel, depending largely upon the quantity of fruit handled and the equipment used. Cleaning, properly done, improves the appearance of the fruit, often makes sorting and grading easier, and does not injure the keeping quality.

Washington, D. C. Issued October, 1931

REMOVING SPRAY RESIDUE FROM APPLES AND PEARS

By H. C. Diehl, *Senior Physiologist*; J. M. Lutz, *Junior Physiologist*; and A. L. Ryall, *Assistant Pomologist, Division of Horticultural Crops and Diseases, Bureau of Plant Industry*[1]

CONTENTS

	Page
Introduction	1
Relation of spray residue removal to spraying practices	2
Relation of maturity to fruit cleaning	4
Cleaning fruit by wiping or brushing	5
Cleaning fruit by solvent methods	7
Washing with hydrochloric acid	9
Washing with alkaline solvents	12
Warming the washing solution	13
Cleaning fruit by solvent methods—Con.	
Additional ingredients in the washing solution	16
Rinsing the fruit	17
Drying the fruit	18
Effect of cleaning methods on keeping quality	19
Types of washing equipment	22
Paddle washer	22
Dipping tanks	28
Cost of removing spray residue	31

INTRODUCTION

CONTROL OF THE CODLING MOTH has become essential in the production of marketable apples and pears in practically all deciduous-fruit districts of the United States, and thorough spraying with lead-arsenate has been for many years the accepted control method. Apples and pears sprayed with lead arsenate bear at harvest time an arsenical residue, and this residue must be removed in the interest of public health.

The provisions of the Federal food and drugs act of 1906, as administered by the United States Food and Drug Administration and as accepted by most public-health authorities, do not permit an arsenical residue of more than one one-hundredth grain of arsenic, in the form of arsenic trioxide, per pound of fruit. This limit is commonly called the world tolerance for arsenical residue.

In some districts, particularly in the arid sections of the Pacific Northwest, it has been found desirable to supplement lead arsenate with other spray materials because of the increasing difficulty of controlling the codling moth and in order to reduce the arsenical residue carried by the fruit without diminishing the effectiveness of pest control.

This bulletin proposes to bring together the latest information thus far obtained from experimental work and practical experience on effectively and safely removing spray residue from apples and pears. It is possible, however, that investigations now being conducted by the United States Department of Agriculture and other agencies eventually may develop still more efficient methods than those described herein.

---

[1] The following persons took part in the research upon which this bulletin is based and in assembling the information that it contains, and their assistance and advice are appreciatively acknowledged: D. F. Fisher, Henry Hartman, W. T. Pentzer, J. R. Magness, B. D. Ezell, E. L. Reeves, and L. A. Fletcher, of the Division of Horticultural Crops and Diseases, Bureau of Plant Industry, and J. E. Fahey, of the Insecticide Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

Commercial fruit cleaning has been carried on in some fruit sections for several years, and the consensus of progressive opinion regarding this practice is that when properly done it improves the appearance of the fruit, often makes sorting and grading easier, does not injure the fruit, and may improve its keeping qualities.

RELATION OF SPRAY-RESIDUE REMOVAL TO SPRAYING PRACTICES

Plans for cleaning spray residues from the fruit should start with the beginning of the spraying program in the spring. It may be desirable to arrange if possible for coordinated spraying and fruit-cleaning supervision through the medium of the horticultural inspector's office, the county agent, or some similar agency. In this way the general directions given in bulletins may be adapted to special needs of a particular section, and the fruit industry may be equipped to do the fruit cleaning under a definitely planned program instead of leaving it to the individual grower, whose information may not always be complete or who may not interpret that information to the best advantage. Cooperative action or community effort may thus solve the broad problem, although actual details of fruit cleaning must be carried out by individuals.

It is not possible to determine accurately the cleaning treatment required by the fruit without some preliminary trials and the chemical determination of the residual arsenic on the cleaned fruit. A number of important variables may affect the quantity and character of the spray residue on the fruit at harvest time. Among them are varietal differences; concentration of the lead arsenate used; the spray materials used in combination with lead arsenate; the methods and dates of spray applications; and the weather conditions, particularly rainfall, during the growing season. The time of application of the last spray is important, especially if combination lead-arsenate-oil sprays are used.

In the Pacific Northwest the important apple varieties, when cleaned immediately after harvest, range themselves in about the following order of decreasing difficulty of cleaning, either by washing or by dry cleaning: Esopus Spitzenburg, Arkansas Black, Winesap, King David, Delicious, Stayman Winesap, Jonathan, Yellow Newtown, Rome Beauty, and Winter Banana.

The number of spray applications and the strength of arsenate of lead used should be the minimum required for satisfactory control of the codling moth. Attention of growers is called to the spray recommendations prepared by the various State horticultural authorities or experiment stations. These suggestions are usually designed to aid the grower in obtaining maximum pest control with a residue load that can be removed with the least difficulty.

In the more arid fruit-growing sections, such as the Pacific Northwest, apples or pears sprayed more than three times with lead arsenate in concentrations of not over 2½ pounds to 100 gallons of water usually will require a washing treatment in order to reduce consistently the quantity of arsenic in the spray residue below the world tolerance for arsenic. The larger the number of applications and the later in the season these applications are made, the greater will be the quantity of spray residue on the fruit at harvest time.

In the Eastern and Middle Western States, because of the great variation in local conditions, it is difficult to determine from the number of spray applications the amount of residue that will be on the fruit when it is harvested. The amount of rainfall and the time of applying the arsenical spray material are the predominating factors in determining the amount of residue. Therefore, to avoid uncertainty, it is very desirable to have a chemical analysis made to determine the amount of spray residue. Fruit carrying the heaviest residue should be selected as the sample for analysis so that the grower may know the worst about his crop. Different varieties, as well as lots that have received different spray applications, should be analyzed separately.

It should be emphasized that omitting late sprays or applying reduced amounts of spray material in an attempt to avoid the necessity of fruit washing may result in heavy losses from wormy fruit, especially in sections where late-brood infestation is severe.

It has been suggested that arsenical dusts be substituted for liquid sprays in order to lessen the fruit-cleaning problem, and in some cases with the hope that washing would not then be necessary. In the arid Pacific Northwest districts dusting is of little value in pest control; but even where it can be employed it generally does not facilitate residue removal. The greatest difficulty has been a greater lack of uniformity in distribution of residue on the fruit where dusting has been tried than in the case of liquid sprays.

Growers using combination lead-arsenate mineral-oil sprays should apply the material soon after it is mixed and not allow it to stand in the tank or in the pipes of a stationary spraying outfit. Very uneven spray residues may result from such delayed application and can be removed only with the greatest difficulty.

Even when spraying is thorough the residue load on fruit taken from different parts of the same tree will show some variation. Rainfall or the use of an overhead-sprinkling system for irrigation may cause a heavier deposit on fruit in the lower portion of the tree because of washing from the upper portions. The drip occurring during the application of spray material is also responsible to a considerable extent for the greater residue load on the lower fruit. When rain or sprinkling water falls directly on the fruit there may be a weathering effect and a reduction in the amount of residue.

The important point in connection with this uneven spray deposit is that although the average residue load on apples or pears from a given tree may be relatively low, and so meet the requirements of the food and drugs act, it is the individual fruits with heavy deposits that often cause trouble. The regulatory officials, in sampling for spray residue, consider as one factor in forming their judgment the fruit showing the heaviest spray residue; therefore, a small quantity of fruit bearing considerable spray residue may endanger the marketability of a whole carload.

The use of spreaders with lead-arsenate spray has not made the residue easier to remove by washing, unless the spreaders contain hydrated lime, nor has it materially reduced blotching on the fruit.

The type of lead arsenate used in spraying does not materially affect the ease of cleaning, provided nothing is added to increase its adhesive qualities. The presence or absence of deflocculators in lead arsenate does not significantly influence the facility with which the fruit is cleaned.

When mineral oils with low volatility and with a viscosity of about 85 seconds Saybolt or more are used with or after applications of lead arsenate, the combined residues generally interfere with cleaning fruit by either dry or solvent methods.

Mineral oil of fairly high volatility and with a viscosity of about 75 seconds Saybolt or less, properly used in combination with lead arsenate, does not significantly interfere with fruit washing if the last application of such combined spray is made some time prior to harvest and if the lead-arsenate residue on the fruit is not excessive. In the Pacific Northwest the last application of combination lead-arsenate mineral-oil spray should be made at least six weeks before harvest. It is possible, through the proper use of mineral oils as spray material, to reduce the quantity of lead arsenate required for effective control so that the amount of arsenical residue will also be materially reduced.

The use of fish oil in combination with lead arsenate tends to make fruit washing more difficult. However, if fish oil is used in the first-brood spray applications and is not used in more than two sprays, the fruit can generally be cleaned without serious difficulty when the acid solvent is used, although it may be necessary to warm the cleaning solution. There is some indication that the alkaline solvents are distinctly helpful in removing residues of combined fish-oil lead-arsenate sprays.

The use of hydrated lime or Bordeaux mixture with lead-arsenate sprays generally facilitates the removal of spray residues when hydrochloric acid is the solvent used in washing. The addition of 1 or 2 pounds of hydrated lime to each 100 gallons of spray in the last two applications will facilitate residue removal and may reduce the arsenical calyx injury that often occurs in some districts because of the formation of water-soluble arsenic. Heavy lime sprays used late in the season in some districts to lessen psylla damage are easily removed with a dilute hydrochloric-acid wash. Solvents other than acid do not effectively remove residues of lime or Bordeaux mixture in combination sprays.

Removing lime-sulphur from fruit has been found difficult. Fortunately, the climatic conditions favoring development of the scab disease for which lime-sulphur is generally used are not especially conducive to the development of the codling moth. The arsenical residues, therefore, are usually not especially heavy in regions where lime-sulphur is used as a summer fungicide, and washing is not often required. Lime-sulphur residue is more effectively removed by dry cleaning (wiping or brushing) than by washing, unless brushes or wipers are used in the washing.

RELATION OF MATURITY TO FRUIT CLEANING

The maturity of the fruit has a marked influence on the facility with which it can be cleaned by any method. All varieties of apples are more easily cleaned at harvest time than after storage. The development of waxy or oily materials on the surface of the fruit, which makes satisfactory cleaning difficult, apparently takes place throughout the growing season, but becomes very noticeable after harvest, particularly on some varieties of apples, such as Winesap, Arkansas (*Mammoth Black Twig*), Arkansas Black, and Paragon, as the fruit approaches a ripe condition.

Washing immature fruit before the lenticels or pores have been closed with corky tissue may result in injury, particularly in varieties such as Jonathan apples or Bartlett pears. If it is necessary to increase the strength of the solvent, or to warm it, or to prolong the exposure of the fruit to the cleaning solution, there is danger of serious damage through spotting or cracking of the skin.

As the maturing fruit becomes softer it is also more subject to injury by mechanical means and therefore more liable to the development of decay. The sooner the fruit is cleaned after being picked the more easily the cleaning can be done and the less the risk of damage.

In any event, fruit should be cleaned while it is still hard or firm. In order to accomplish this the following practices should be followed: (1) Harvesting at the proper stage of maturity; (2) coordinating the picking and packing operations so that the fruit will be cleaned and packed as soon as possible after it is harvested; (3) holding the fruit in the coolest space available, preferably in cold storage, if cleaning and packing are unavoidably delayed.

CLEANING FRUIT BY WIPING OR BRUSHING

The first commercial efforts to remove spray residue from apples and pears were made with dry-cleaning methods, such as brushing or wiping with cloths. These methods seemed the most simple and convenient and did not involve many changes in the methods of handling the fruit. Figure 1 shows one type of dry-cleaning machine. Experience has shown, however, that when cost, relative cleaning efficiency, safe handling of the fruit, and tonnage capacity are considered, the best dry-cleaning methods are invariably less economical and less satisfactory than suitable washing methods for the removal of spray residue. However, if fruit is cleaned primarily to improve its appearance by removing dust and by polishing, dry cleaning is satisfactory if done with proper care.

Lack of efficiency in dry-cleaning methods is revealed by the results of hundreds of analyses, which indicate that brushing or wiping, under the best conditions, does not consistently remove from apples more than about 30 per cent of the original quantity of spray residue when the residue on uncleaned fruit is not more than 0.04 grain of arsenic trioxide per pound. With heavier original deposits the proportionate amount removed may be greater, but the absolute amount left is often considerably above the world tolerance.

More than half of the arsenical load on apples generally is carried in the calyx and stem ends. Dry cleaning can not effectively remove this residue, which is included in the analysis. Brushing or wiping may, in some cases, actually rub the residue into the waxy coating of the fruit and add more residue to some of the fruits than they bore originally, especially if the cleaning equipment itself is not kept properly clean.

To a certain degree dry cleaning equalizes the amount of spray residue on different apples in the same lot. Therefore, while those with large original deposits may become cleaner under the treatment, those with small original deposits may have more residue added. The brushing or wiping will entirely remove only a relatively small proportion of the residue from all of the fruit, even if the equipment is properly cared for.

Repeated dry cleaning with the same equipment has not materially reduced the quantity of residue below that remaining after one cleaning treatment.

Attempts to increase the rather limited capacity of dry-cleaning machines by hurrying the fruit through them generally result in improper cleaning and increase the possibilities of injury to the fruit.

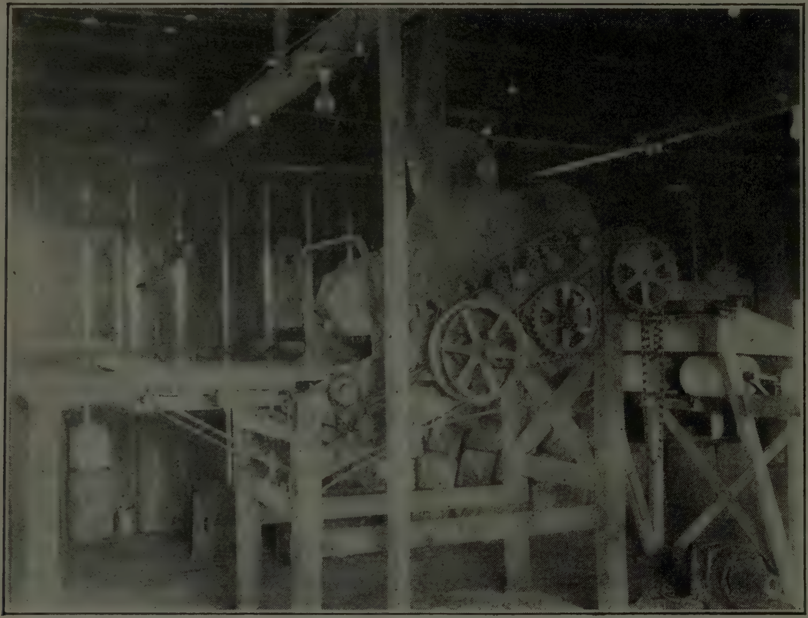


FIGURE 1.—Dry-cleaning machine using cloth wipers

A very decided disadvantage of most dry-cleaning methods under commercial conditions has been that it is practically impossible to constantly adjust the equipment to the size of the fruit. Where the sizes are extremely variable, sorting out extremes before dry cleaning may help to give more uniform cleaning results with less damage to the large fruit. Proper adjustment of dry-cleaning equipment is not always easy, and its lack may cause considerable bruising and other damage.

The efficiency of cloth wipers is determined largely by the rate at which the fruit moves through the machine, by the cleanness and dryness of the cloths, and by suitable adjustment of the cleaning surfaces. The efficiency of brush cleaners is determined largely by the cleanness of the brushes, their ability to retain their original resiliency, their proper adjustment in the machine, and the rate at which the fruit moves through the machine.

Using solvents to clean cleaning cloths or brushes while they are in the machine is not satisfactory. Changing the cloths or brushes at least every two hours is essential under ordinary commercial conditions. Some packers discard the old cloths and replace them with new ones; others launder or steam clean the soiled cloths before using them again. Soap and hot water or gasoline are usually available and are effective for cleaning the brushes, especially if applied with a scrubbing brush. At least one extra set of cloths or brushes for replacement while the used ones are being cleaned should be provided.

A suction device for constantly removing loose dust and residue particles from the machine will help materially in keeping the equipment clean.

Under commercial handling and storage conditions there will be very little loss from excessive wilting of the fruit after dry cleaning. However, there is a possibility of loss from slack packs if such fruit is held in storage with a low air humidity. The best relative humidity for apple and pear storage is about 85 per cent.

From the viewpoint of handling, the dry cleaning of pears is generally much less desirable than washing. This is also true to a lesser degree for the more tender skinned apples, such as the Winter Banana. Some types of dry-cleaning equipment are entirely unsuited for pears. In general, any method that subjects fruit to much rolling or contact with parts of the equipment or with other fruit is likely to cause mechanical injury. The use of roller conveyors for certain varieties of pears is also dangerous. The bristles of brush cleaners may puncture the surface of the fruit and allow decay to start.

Hand wiping with sponges or dry cloths or with cloths dampened with water or other solvent liquids is not effective in removing spray residue, and the cost of such a procedure is generally prohibitive.

Oil-soaked rags have been occasionally used in dry-cleaning equipment. Although they impart a high polish to the fruit, they are usually not so effective as dry cloths in removing residue.

CLEANING FRUIT BY SOLVENT METHODS

Several years' experience has shown that arsenical residue can be removed from apples and pears most effectively, cheaply, and safely by the use of some chemical solvent for the lead arsenate. Hydrochloric acid (commonly termed "muriatic acid") has been found the most satisfactory of all the solvents tested.

Alkaline washes have also been used and are quite effective, but because of the solvent action of some of the alkaline materials on the waxy coating of the fruit their use is often not entirely free from danger of wilting or injury to the fruit. Alkaline washes are generally not very effective in removing residue of sprays containing lime, and an acid wash is to be preferred.

It can not be assumed that any particular washing treatment will clean all fruit regardless of its previous treatment in either spraying or harvesting. Every fruit-cleaning method has its limitations.

The sprays used, as well as their manner of application, may materially modify the facility with which any method will remove spray residue.

Spraying with solvents for arsenical residues while the fruit is still on the tree has been attempted, but has not been found effective in cleaning the fruit and may cause serious injury to the fruit and the tree, as well as to the spraying machinery. Water alone has but little solvent action on arsenical spray residues, and spraying with water or even with soap and water just before picking has invariably proved disappointing.

Any washing method that applies the solvent solution to the fruit by diffused spray, flood wash, or flotation, or by a combination of these, with or without brushes to scrub the fruit, ordinarily gives satisfactory results where necessary precautions are observed.

The ultimate choice of a machine for washing fruit will generally be influenced by the initial cost of the equipment, the cost of operation per unit of fruit, the suitability of the equipment to local conditions, its adaptability to the space available, and particularly to the general mechanical and cleaning efficiency of the machine, as well as the absence of possibility for damage to the fruit.

To prevent the contaminated acid solution from penetrating into the core of the fruit and thereby bringing about decay, machines that use either the direct jet spray or submerge the fruit 4 to 6 inches or more below the surface of the washing solution should be avoided, particularly for apple varieties that frequently have open calyx tubes. These include Jonathan, Esopus Spitzenburg, Stayman Winesap, Ortley, White Pearmain, and sometimes Delicious. Such types of machines are no longer manufactured commercially and should not be constructed by the grower. Immersing the fruit in the cleaning solution while in boxes is open to the same objection as other submersion methods.

A certain amount of agitation is essential in obtaining the greatest efficiency of the dipping method. A slight turning motion of the fruit increases cleaning efficiency in most commercial washing machines of the spray or flood type, but this should not be of such a character as to bruise or injure the fruit. Pears are best handled by conveyors causing a minimum of motion of the individual fruits. This may require the application of the solvent from diffused-spray jets above and below the conveyor in order that the fruit may be covered with solvent on all sides.

"Prewashing" the fruit with water or very dilute solvent ordinarily adds very little to the cleaning efficiency of the operation and is not recommended. Its chief effect is to remove dust and spores of fruit-rot fungi, which are satisfactorily removed by ordinary methods of washing. A distinct disadvantage in the use of the prewash is the constant dilution of the solvent in the washing equipment by carry-over from the prewash. The same dilution may occur when wet fruit is washed.

The strength of the solvent solution should be tested often, the frequency depending upon the conditions prevailing during the treatment. Testing the concentration of the acid washing solution every hour has been found necessary in some cases where such materials as lime or Bordeaux mixture are being removed, because of the chemical neutralization of the acid by these materials. Note should be kept of the acid strength, analyses, and other pertinent information obtained during the washing process, not only to keep the fruit-cleaning operation of the current season at highest efficiency but also to obtain a record which may be useful in planning the spraying and fruit-cleaning programs of subsequent seasons. Directions for testing the hydrochloric-acid solution are given on page 10.

WASHING WITH HYDROCHLORIC ACID

For removing arsenical spray residues the commercial or technical grade of hydrochloric or muriatic acid is used. The acid should test 20° Baumé, which is equivalent to about 32.1 per cent actual acid. A slight yellow tinge in the acid indicates certain impurities, which, however, do not detract from its value as a cleaning agent.

The acid may be purchased from chemical companies in 10 to 20 gallon carboys, protected by wooden cases, at a cost varying from about 10 to 40 cents a gallon, depending on the quantity purchased and on the distance that the chemical has to be shipped.

Concentrated hydrochloric acid is very corrosive and must be handled with care. It will attack cloth, leather, and some metals unless quickly washed off with water or neutralized by soda, lime, or some other alkaline substance. Therefore, where acid is used for washing fruit, it is desirable to keep on hand a quantity of hydrated lime, carbonate of lime, or common baking soda to be used in case of accident.

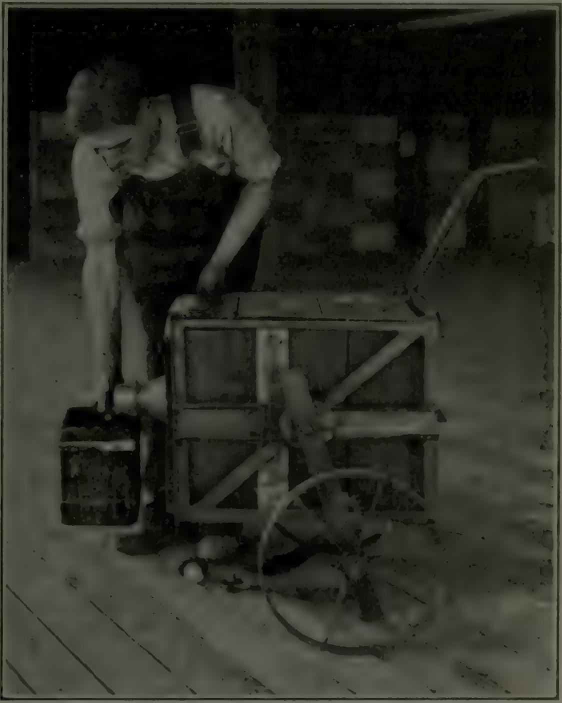


FIGURE 2.—Carboy-tilting frame to aid in pouring concentrated acid from the large carboys

If the acid is kept in the carboy, a tilting frame (fig. 2) will be found convenient in pouring it into a smaller container, which should be of glass, porcelain, enamel, or earthenware, preferably in single or multiple gallon dimensions. Great care should be taken in pouring the concentrated acid to keep it from splashing, particularly in drops that might injure the eyes. The fumes of concentrated acid are irritating to the throat and nasal passages, therefore care should be taken to avert the face somewhat when pouring acid into an open container.

Acid siphon pumps are very useful for transferring the concentrated acid from carboys to smaller containers with a minimum of inconvenience and danger. However, the pump should be removed from the carboy after use, to prevent the acid being accidentally siphoned out of the carboy.

Proper washing of apples and pears generally requires a solution of at least 1 gallon of commercial hydrochloric acid to 100 gallons of water. For average lots of fruit with no particular spray-material complications, 2 to 3 gallons of commercial acid to 100 of water usually are enough. Use of solutions of more than 4 gallons of acid to the hundred is not recommended, because the increase in cleaning efficiency is generally not proportionate to the additional quantity of acid used, and it may considerably increase the cost of washing. The use of such high acid concentrations also places a relatively greater burden on the rinsing section of the washing equipment, and this burden is ordinarily not provided for in the construction of the machines.

A certain amount of the acid solution is carried away on the fruit as it passes through the washer. This loss should be replenished from time to time from a storage barrel filled with cleaning solution of proper strength and arranged to stand beside or over the washing machine. If this loss and the volume of the washing tank are known, the additional acid and water may be added directly to the tank, but this is ordinarily not so convenient as is the method mentioned above.

PREPARATION AND TESTING OF THE ACID SOLUTION

Table 1 is designed for use in connection with the preparation of the acid solution. It may be used either in making up the fresh solution or in increasing the acid strength of the partially spent solution to the desired strength.

TABLE 1.—*Quantities of 20° Baumé commercial hydrochloric acid (containing about 32 per cent actual acid) to be used in preparing solutions of desired strength*

Acid solution desired	Quantity of acid to make indicated quantity of solution														
	100 gallons			150 gallons			200 gallons			270 gallons			300 gallons		
Per cent	*Gal.*	*Qt.*	*Pt.*	*Gal.*	*Qt.*	*Pt.*	*Gal.*	*Qt.*	*Pt.*	*Gal.*	*Qt.*	*Pt.*	*Gal.*	*Qt.*	*Pt.*
0.05	0	0	1¼	0	1	0	0	1	½	0	1	1¼	0	1	1¾
.10	0	1	½	0	1	1¾	0	2	1	0	3	¾	0	3	1½
.20	0	2	1	0	3	1½	1	1	0	1	2	1½	1	3	1
.30	0	3	1½	1	1	1¼	1	3	1	2	2	¼	2	3	½
.40	1	1	0	1	3	1	2	2	0	3	1	1¼	3	3	¼
.50	1	2	½	2	1	¾	3	0	1	4	1	0	4	2	1½
.60	1	3	1	2	3	½	3	3	¼	5	0	¾	5	2	¼
.70	2	0	1½	3	1	¼	4	1	1	5	3	1½	6	2	¾
.80	2	2	0	3	3	¼	5	0	0	6	3	¼	7	2	¼
.90	2	3	½	4	1	0	5	2	1	7	2	¾	8	1	1½
1.00	3	0	1	4	2	1½	6	1	0	8	1	1½	9	1	1¼
1.25	3	3	1¼	5	3	1	7	3	½	10	0	½	11	3	0
1.50	4	2	1½	7	0	½	9	1	1¼	12	2	1½	14	1	0
1.75	5	2	0	8	0	1¾	10	3	1¾	14	3	¼	16	1	1¾
2.00	6	1	0	9	1	1¼	12	2	½	16	3	1½	18	3	½
2.50	7	3	½	11	3	0	15	2	1¼	21	0	1¼	23	2	¼

The strength of the acid solution may be tested during the washing process by a simple titration method. The equipment necessary for this determination may be obtained in most drug stores or can be purchased directly from dealers in chemical supplies. The test requires one 10 c. c. (cubic centimeter) bulb pipette, one 10 c. c. measuring pipette of the Mohr type (graduated to 0.1 c. c.), two ordinary glass tumblers, and a standard solution of sodium bicarbonate consisting of 23 grams of sodium bicarbonate to 1,000 c. c. of water and containing methyl orange indicator sufficient to give a good yellow color. The total cost of the apparatus and solution is generally about $1.

To determine the strength of the acid solution, use the following procedure:

Take a glassful of dilute acid solvent from the washing solution, and from this take a 10 c. c. sample by means of suction on the bulb pipette, allowing the excess to flow from the pipette until the liquid is even with the mark on the upper stem, indicating that the pipette contains 10 c. c. of solution. Allow the measured solution to drain into the second glass. Fill the graduated measuring pipette with standard sodium bicarbonate solution, adjusting the level of the liquid to the 0.0 c. c. mark; then allow the bicarbonate solution to flow slowly from the pipette into the measured sample of acid solvent, all the while gently agitating the latter by shaking the glass or stirring the liquid with a glass rod. As soon as the color of the acid solution changes from red to yellow note the number of cubic centimeters of soda solution that have been used. This number divided by 10 will give directly the percentage of actual hydrochloric acid in the solution being tested. For example, if 6.4 c. c. of the standard sodium bicarbonate solution is used to neutralize 10 c. c. of acid, the strength of the acid will be 0.64 per cent by weight.

To increase this 0.64 per cent solution to 0.75 per cent, for example, it is necessary to add acid to make up the difference of 0.11 per cent. By referring to Table 1 it will be noted that to make 100 gallons of solution having an acid strength of 0.10 per cent, 1 quart ½ pint of 20° Baumé commercial hydrochloric acid is required. The quantity of commercial acid to be added to 100 gallons of water is, therefore, one and one-tenth times 1 quart ½ pint, or 1 quart 1¾ pints. For larger quantities, calculations should be made on the basis of the other figures given in the table. It is readily apparent that the procedure for making up a fresh solution of a given strength will be somewhat simpler.

The bulb pipette should be used only for measuring the acid solution, and it should always be first rinsed with some of the acid to be tested. The measuring pipette should be used only for transferring the standard soda solution to the sample of solvent to be tested.

It will be found useful to keep a permanent record of the acid tests and other data, and for this purpose the following form is suggested. On the reverse side of this form may be printed general fruit-cleaning suggestions.

FRUIT-CLEANING RECORD

MOUNTAIN VIEW GROWERS ASSOCIATION

Packing House No. ------ Machine No. ------

Date	Variety	Grower	Washing-solution test					Washing-solution temperature					Arsenic analysis	Remarks or spray schedule information
			7 a. m.	10 a. m.	1 p. m.	4 p. m.	6 p. m.	7 a. m.	10 a. m.	1 p. m.	4 p. m.	6 p. m.		

The time required to clean fruit satisfactorily depends upon a number of factors, such as the variety and maturity of the fruit, the amount of residue on it, and the concentration, temperature, and method of applying the acid solution.

In using flotation paddle washers, such as the one described in detail in this bulletin (p. 22), exposing the fruit to the cleaning solution for 3 to 5 minutes is sufficient. In using a dipping method in which there is little agitation of the solvent, five minutes of exposure is generally required. When the solution is pumped or thrown over the fruit in the modified dipping tank, an exposure of 2 to 4 minutes is usually sufficient. In the commercial washing machines 30 to 60 seconds of exposure usually suffices. Prolonging the exposure beyond the times indicated does not generally result in marked improvement in cleaning efficiency, although soaking the fruit in the acid solution may result in slightly greater removal of residue through mechanical loosening of dust and residue particles.

The acid solution and the rinse tanks should be emptied at least once a day, or after about 1,000 bushels of fruit has been cleaned, and an abundance of fresh water should be used to clean them; if necessary they should be scrubbed on the inside. If live steam is available it can be utilized to disinfect the machines and kill accumulated spores of rot fungi. Formaldehyde may also be used as a disinfectant. It may be put into the washing solution and the rinse water at the end of the day, 1 pint of commercial formaldehyde to 100 gallons of water, circulated through the machines, and allowed to remain in the tanks over night. If the tanks and machines are thoroughly cleaned and flushed with fresh water this treatment will not be necessary. No practicable method of disinfecting the fruit during the short period of the washing process has been found.

When the acid-solution tanks are emptied the waste acid should be drained away from stonework, concrete, brick, or iron pipes, which it will attack and corrode in dilute solution. The used solution should be kept out of irrigation ditches and away from trees and other useful plants. A sand pit is an ideal depository for the waste washing solution and also for the overflow from the rinse tank. Where the waste acid must be diverted to sewerage systems, it is well to dilute it with copious quantities of water as it flows into the sewer, and to flush the latter with fresh water after the used solution has passed out.

WASHING WITH ALKALINE SOLVENTS

A number of alkaline materials, including solutions or mixtures of sodium hydroxide, sodium carbonate, trisodium phosphate, borax, or similar substances, generally at temperatures of 100° F. or above, have been used for washing apples and pears.

Sodium hydroxide, commonly called caustic soda, when used alone in concentrations up to 1 per cent by weight, is an effective solvent for arsenical residues where no basic fungicidal residues are involved; but its use is attended with considerable danger unless closely supervised. It is not generally recommended for use by growers or packers in smaller packing establishments, particularly because it makes thorough rinsing very difficult and the caustic soda attacks the waxy coating of the fruit as well as the residue. It is particularly likely to injure russeted pears and should not be used on such varieties.

Sodium carbonate, commonly called soda ash, or similar milder alkalis may be used with a fair degree of safety in concentrations of about 5 per cent by weight, but their full effectiveness is generally obtained only when the washing solution is warmed to 100° F. or above.

While the cleaning efficiency of the alkaline washes and their satisfactory use when employed under proper supervision and with proper care are fully recognized, experience has indicated that hydrochloric acid is more easily used, is more economical, and is generally preferable for the average grower or packer handling fruit with no particular residue difficulties.

WARMING THE WASHING SOLUTION

Raising the temperature of the acid solution gives increased cleaning efficiency in washing apples from which the residue can not otherwise be satisfactorily removed. The temperature of the solution for this purpose should be at least 80° to 85° F., preferably 90° to 100° for consistently good cleaning. With such temperatures it is often found that without sacrificing cleaning efficiency the acid concentration can be materially reduced below that required when the solution is cold. Often the saving in acid consumption more than compensates for the cost of heating.

The higher temperature in the solution seems to increase to a certain degree the chemical reaction between the lead arsenate and the hydrochloric acid and causes a softening of the waxy or oily materials on the surface of the apple, so that the residue can be more effectively reached by the cleaning solution.

The acid solution at higher temperatures also reacts more rapidly with any metal parts exposed to it, and so the corrosion problem is somewhat increased by warming the washing solution.

Experience has shown that there is no heat injury to mature apples and pears when they are exposed to washing solutions at temperatures of 100° F. or below for periods up to two minutes, nor is there any significant increase in fruit temperature during that time. However, when temperatures higher than about 100° are used for more than two minutes there may be direct immediate injury to the fruit or injury that may appear later in storage.

It is true that lots of fruit are sometimes washed in alkaline or acid washing solutions at temperatures as high as 110° F. It may be possible to do this without injury if the fruit has a waxy coating and if the cleaning operations are closely supervised. However, it is not recommended as safe, particularly for the reason that in order to maintain a considerable volume of washing solution at temperatures around 110° while cold fruit is passing through it is often necessary to raise the solution to much higher temperatures at the beginning of the operation. In such cases also the temperature may go above 110° when the machine is idle and the first lots of fruit going into the washer when operation is resumed may be washed in very hot solutions, with resulting injury to them.

It is not probable that warming the solution will be necessary in order to clean average lots of fruit satisfactorily, unless they carry excessive arsenical-residue deposits, have received applications of heavy-type oil sprays, or unless their cleaning has been delayed after harvest until they have become very waxy. Under such conditions warming the acid solvent may be very helpful if consistent cleaning to the world tolerance can not be obtained by any other means.

The heating apparatus used should have sufficient capacity to maintain the washing solution at a temperature of at least 80° to 85° F., and temperatures of 90° to 100° may be required if the fruit has been heavily sprayed and is very waxy. Methods of warming the solution are described in the following paragraphs.

CIRCULATION THROUGH COILS

One of the least expensive methods of warming the solution is by circulating it through coils in an improvised stove. An ordinary 50-gallon oil drum, costing about $3 to $5, may be used as a stove by cutting a door in one end, laying it on its side on a fireproof stand (such as a box of sand) and fitting a stovepipe into the upper side. A coil of 1-inch wrought-iron pipe is placed within the drum, bent so that it lines one side and the top of the stove, with the intake at the bottom of the stove and the outlet at the top, thereby favoring the natural circulation of the liquid within the coil. If possible the pipe should be coiled into the desired shape rather than made by the use of fittings. The fewest possible sharp turns in the system, the use of bends in the pipe instead of fittings, and the installation of pipe no smaller and not much larger than 1 inch in diameter will facilitate warming of the liquid and will minimize corrosion. Four or five turns of pipe in the stove should be sufficient, giving about 15 feet of heating coil. Because of the corrosive effect of the warm acid solution it will be necessary to replace the coil occasionally, but this expense should not exceed $5.

In order to convey the cleaning solution from the tank to the heater, the former is tapped near the bottom. A small centrifugal pump of one-eighth or one-fourth horsepower will be sufficient to drive the liquid through the system and will make the heating possible without an excessively high temperature of the acid in the coils, thereby reducing corrosion. To secure circulation in some commercial washing machines one end of the coil can be attached to the pipe carrying the acid from the pump. When convection alone is resorted to for the circulation the temperature of the acid in the coils becomes considerably higher than that in the tank, and the life of the coils is considerably less. A petcock at the highest point in the pipe, which can be opened to allow the escape of entrapped air, will facilitate somewhat the circulation of the liquid where natural circulation only is depended upon.

The total cost of such a system has been from $15 to $20.

Wood has been satisfactorily employed for fuel in the heater. If coal is used, some sort of grate may be necessary. It will usually be necessary to begin circulating and warming the acid solution an hour or two before the cleaning is to begin. This type of heater generally does not have a capacity adequate for the larger sizes of commercial washing machines.

CIRCULATED HOT WATER

A modification of the system described above involves the use of a coil in the cleaning solution as well as in the heater. A water reservoir is provided, usually above the stove, high enough to fill the pipes with water, and a pump is used to circulate the hot water from the coils in the stove through those in the tank. This system is generally satisfactory, and both the pump and the coils will last longer than if the acid solution itself is circulated directly through the heating coil; but the efficiency is obviously not as great as in the system first described.

STEAM COIL

Where a small boiler can be provided economically, or where low-pressure steam is required for other purposes, the solution can be warmed very efficiently by means of a steam coil carrying the steam to the acid-solution tank, which is drilled at the feeding end and at the bottom to receive a 1-inch pipe, preferably of lead, which is fitted to the iron delivery pipe.

It is not necessary to build up a system of several coils in the tank. Usually the pipe is given a turn about the tank and is brought out at the end opposite to that at which it entered. The pipe should preferably rest on cleats in the bottom of the tank. Inlet and outlet valves are provided for controlling the flow of steam through the lead pipe in order to regulate the temperature of the cleaning solution.

RELEASE OF LIVE STEAM

Introducing live steam directly into the liquid has been found a convenient method of warming the acid solution. Condensation of the escaping steam tends slowly to weaken the acid, but this is not an insurmountable difficulty and merely requires closer attention to maintenance of the required acid strength.

ELECTRIC HEATERS

It is now possible to obtain suitably prepared silver-plated electric heaters which can be used for warming the acid solution. These heaters are of the bayonet type and are made in 5 and 8 kilowatt sizes. The local power or electric supply company can usually obtain them. They sell for about $28 for the 5-kilowatt size and $40 for the 8-kilowatt size. For heating a 200-gallon tank, two units, one of each size, should be installed to provide temperatures in the acid solution of at least 80° to 85° F. while cold fruit is being washed. Where higher temperatures are needed two 8-kilowatt heaters probably would be the better installation; for machines with 100-gallon acid-solution tanks one 8-kilowatt heater should provide enough heat. These heaters are so made that by proper wiring either the entire heater or only one-half of it can be used; thus with an 8-kilowatt and a 5-kilowatt heater a range of 13, 10½, 9, 6½, 4, or 2½ kilowatts of electricity for heating is available. It is desirable to split at least one of the units so that if the machine is stopped for a time the solution can be kept warm enough by allowing part of the heating unit to operate continuously.

The installation of electric heaters usually requires a larger transformer to give the power requirement and, of course, necessitates some extra wiring, all of which increases the expense of heating by this method. The operation of the heaters consumes considerable power, the consumption being fairly close to their kilowatt rating; so if the power rate is high the convenience of this method of heating is more than offset by the additional cost as compared with that of using a stove and coils. The latter equipment also provides more heat for the packing room, which is a factor to be considered in cold weather, when the solution is most likely to be heated.

ADDITIONAL INGREDIENTS IN THE WASHING SOLUTION

KEROSENE EMULSION

Where exceptional difficulty is encountered in washing apples because of heavy spray-oil deposits or much natural waxiness of the skin, the use of a kerosene emulsion added to the regular acid wash has been found helpful. The emulsion found most satisfactory for this purpose is made according to the following formula:

Two and one-third pounds kaolin.
One gallon water.
Two gallons kerosene, preferably the odorless type.

In making this emulsion a good mixing machine is essential. A small power-driven emulsifier or a stirring rod and propeller are satisfactory for this purpose. This equipment is similar to but of a larger size than that used at soda fountains for stirring certain milk drinks. Any large tin or stoneware jar is suitable as a container for the emulsion.

The kaolin is added to the water and allowed to stand for 5 to 10 minutes. The mixer is then placed in the water and the kaolin and water are mixed thoroughly. Finally the kerosene is added slowly with continuous stirring. After the kerosene is all added the stirrer should be run for about two minutes to complete the emulsion.

The emulsion should preferably be made up fresh each time; if this is impracticable it should at least be thoroughly stirred before use.

Kaolin is a colloidal clay and may be obtained from most dealers in clay products. The washed and ground material should be used for making kerosene emulsions. Ordinary emulsions of kerosene made with soap, casein-lime, or casein-ammonia should not be used, since these emulsifiers are attacked by the dilute hydrochloric acid.

The kerosene emulsion will give significantly increased efficiency only when the temperature of the cleaning solution is above 90° F. It should be used at the rate of 1 to 1½ gallons of the emulsion to 100 gallons of cleaning solution. Because of a loss of kerosene due to volatilization and carry-over in commercial washers, it will be found necessary to add about half the original quantity of emulsion after every two hours of continuous operation. This makes kerosene emulsion rather costly and limits its use to fruit that is very difficult to clean.

Use of the kerosene emulsion must be confined to those types of washers in which there is a distinct agitation of the solvent material. Dipping tanks and paddle-type flotation washers do not supply sufficient agitation.

SALT

Addition of 1 to 3 per cent of common salt to the hydrochloric-acid wash in many cases has resulted in much more thorough removal of the lead-arsenate residue. It increased efficiency of both cold and warm solutions, but the relative increase in removal was usually greater in cold solutions. The use of certain concentrations of salt also makes it possible to wash pears in the flotation-type washer, whereas without salt they will sink in the acid solution. No adverse effects on the keeping quality of the fruit as a result of the use of salt have been found.

RINSING THE FRUIT

Proper rinsing of the fruit is a very important part of the washing process and can do much toward eliminating the danger of injury from soluble arsenic, acid burning, and decay. Three methods of rinsing are suggested in the order of their preference.

(1) Use of fresh water only for rinsing is the ideal condition, but can not always be attained where water is scarce and is sometimes made impracticable by the construction of the rinsing section of the equipment, as in the modified paddle washer and dipping tank. Two or three gallons of fresh water to each box or bushel of fruit should be available, should be allowed to flow over the fruit, and then should be discarded.

(2) In the recirculation of part of the rinse water the fresh water is best added as a final spray or flood over the fruit as it leaves the rinsing section, thus giving the fruit the benefit of a final rinse with water in which there is no carry-over of acid, soluble arsenic, or fungus spores. This water then drains into the recirculating tank and is used over again. If possible the first rinse water passing over the fruit as it enters the rinsing section should be discarded. This prevents the larger part of the acid solution and spores on the fruit from being carried into the recirculated rinse water.

(3) If the same rinse water is used continuously, some substance such as lime may be added to neutralize the hydrochloric acid carried over on the fruit and to render insoluble the arsenic remaining on the fruit after washing. Lime water can be made up by preparing a stock solution of "milk of lime" by slaking 1 pound of fresh quicklime and adding water to make it up to 1 gallon. Usually 1 gallon of this solution added to 50 gallons of rinse water is sufficient. If preferred, hydrated lime can be added directly at the rate of 1½ or possibly 2 pounds to 50 gallons of rinse water. Broken limestone placed directly in the rinse tank may also be used, but is less effective. Lime so used does not leave a conspicuous or undesirable residue. This method does not provide the desirable flushing off of fungus spores, and the process must be carefully watched to see that the lime does not become exhausted by the acid that is constantly being carried over.

Mere rinsing of the fruit in boxes in a tank, even if some fresh water is added, is generally not so satisfactory as the rinsing methods mentioned above. In washing machines the fruit should generally be exposed to the rinsing at least half as long as to the acid. Where alkaline washes are used the exposure in the rinsing section should be equal to that in the washing section. The operator should give constant attention to keeping the rinsing section in good operating condition. It is not necessary to titrate the rinse water with the reagents used for testing the acid in order to determine whether it is becoming acid; it is only necessary to taste the rinse water, as the tongue is sensitive to very small quantities of acid. If recirculated rinse water tastes very faintly sour, and there is an adequate fresh-water rinse at the end, no particular apprehension need be felt provided the water left in the stem or calyx ends of the fruit does not have an acid taste; but if the rinse water has a distinctly sour taste, steps should be taken immediately, either by supplying more fresh water or by adjusting possibly faulty equipment, to remedy this deficiency and so to protect the storage life of the fruit.

DRYING THE FRUIT

If sound fruit is used and if the washing and rinsing operations are carefully done, drying the fruit is not essential to protect its keeping quality, although it may be desirable in order to facilitate packing if fruit is to be wrapped and packed in boxes. In any event, traces of moisture do not impair the keeping quality of the fruit, and the moisture usually disappears entirely while the fruit stands in storage, especially if it is wrapped.

Where it is desirable to remove the adhering water from fruit that has been washed in a dipping tank or in a flotation paddle washer, the fruit may be allowed to dry in the containers after it is taken from the washing equipment. The rate of drying under atmospheric conditions will depend upon the temperature and relative humidity of the air and upon prevailing wind velocities, particularly if the containers are stacked in the open.

It is sometimes possible to remove some of the excess moisture after washing in the dipping or flotation paddle machines by passing the fruit through dry-cleaning equipment. In such cases the cloth wipers or the brush bristles should just touch the fruit, and the machine should be run fast enough to throw off the water droplets from the cleaners. If this is done, it will not be necessary to replace the cloths or brushes as often as when the machines are operated for dry cleaning. This operation is also effective in removing insect specking, dirt, and other residues that may not come off in the washing process. It may also give the fruit some degree of polish.

Several types of driers are used on commercial washing machines, and most of them are quite satisfactory in removing sufficient moisture to permit satisfactory packing and to safeguard the keeping quality of the fruit. Three general types are found:

One type employs an air blast, which actually blows the water off mechanically. No method of drying involving the evaporation of water has proved successful.

Another type causes contact of the fruit with either absorbent cloths or toweling which takes up the rinse water and from which the water is squeezed periodically by a rubber roller. This treatment is also effective in removing insect specking, dirt, and other residues not removed by washing.

The third type employs rotating cylindrical brushes alone or in combination with metal rollers designed to remove the water. In the latter case the fruit may be polished in the drying process. While it is not generally essential, some packers prefer this polish where a slight lack of luster is found on fruit that has been through the washer. Any additional handling such as occurs when fruit is passed through a polisher may increase the risks of injury and therefore should be well justified and tested before it is done.

EFFECT OF CLEANING METHODS ON KEEPING QUALITY

While dry cleaning of apples can be done on a commercial scale in such a manner that there will be no exceptional loss from decay or deterioration in storage, there is a greater risk of damage than when washing methods are used. Bruising; mechanical injury by dirty, waxy cloths or by conveyors in the equipment; spreading of decay contamination through microscopic cuts or injuries to the skin by the smearing action of the wipers; puncturing by bristles in brush cleaners—all these are possible where dry-cleaning methods are used.

The dry cleaning of pears is especially hazardous. This is particularly true of tender-skinned varieties such as Comice and Anjou, on which dry cleaning may produce skin scratches, abrasions, and stem punctures. The smaller pears are generally the most seriously affected, the injury being manifested as a dark discoloration of the skin accompanied by excessive wilting. This is due to abrasive action when the gritty "stone cells" located just beneath the skin are pounded by the wiping cloths or brushes.

The prevalence of rot is mainly dependent upon skin punctures and abrasions. The severity of these is, of course, determined by the character of the handling that the fruit receives.

Mature apples and pears can be washed satisfactorily with dilute hydrochloric acid under commercial conditions without serious injury to the fruit, if certain precautions are taken. These are generally simple and may prevent rather serious injury which might occur if the washing were carelessly done.

The possible injuries, which are considered in greater detail in the following paragraphs, may be classified as follows: Arsenical injury at the calyx or stem, hydrochloric-acid burning, alkali injury, chemical injury at the core, and heat injury.

Two general suggestions for avoiding trouble may be given in addition to those already mentioned. All decayed specimens should be sorted out before the fruit is washed, to prevent them from contaminating the washing and rinsing solutions. Fruit should not be left in the washing machines or dipping tanks during rest periods or when it is necessary to discontinue operation. This is especially imperative when warm cleaning solution is used.

Arsenical injury is usually localized in the calyx region, although occasionally it is found at the base of the stem and rarely on the cheeks. It appears as depressed black or dark-brown areas or spots and is sometimes followed by storage rots. The same type of injury has also occurred on heavily sprayed apples while still on the trees during rainy fall weather, but it is more common on picked apples that are allowed to stand unprotected from the rain. It has been observed on stored uncleaned fruit that was packed wet. Arsenical injury of this sort on uncleaned apples is apparently due to accumulation of soluble arsenic from the arsenical sprays applied. This injury starts when moisture is present. The same type of arsenical injury occurs when spray residue is not completely removed from the deep calyx region, the disintegration of the lead arsenate to form soluble arsenic salts apparently beginning in the washing process and continuing under the influence of solvents or moisture retained on the fruit.

Reasonably thorough removal of the spray residue, proper rinsing, and consistently changing the acid solution at the intervals already suggested will protect fruit against this trouble. The use of a final fresh-water rinse as the fruit leaves the washing machine is also essential for removing traces of soluble arsenic.

The addition of lime to the rinse water as a precautionary measure has been mentioned and may be desirable under certain conditions. The lime not only neutralizes the acid solution left on the fruit but also converts the soluble arsenic remaining on it into a form relatively insoluble and noninjurious to fruit.

Hydrochloric-acid injury is distinguished from arsenical injury primarily by its lighter color and by its occurrence on any portion of the fruit surface rather than being confined principally to the calyx end. The injured parts usually have a bleached appearance, frequently accompanied by cracking through the center of the area. The injured areas or spots may also become depressed with age, and sometimes the presence of soluble arsenic causes portions of them to turn black.

Prolonged exposure to the acid solution and too high concentration of the acid increase the risk of injury. Inadequate rinsing or neglect of rinsing will almost surely bring about acid injury to the fruit, although traces of acidity resulting from carry-over, as already mentioned, may be present in the rinse water without producing acid injury, provided a final fresh-water rinse is applied. Hydrochloric-acid injury is really caused by neglect or carelessness and generally is not an important factor in commercial operations.

Alkaline solvents are difficult to rinse off and may cause arsenical injury. Furthermore, apples washed with alkaline solvents may show a superficial brownish deposit in the calyx basin, apparently the effect of the alkali on the pubescence in the calyx.

Occasionally the alkaline solution itself causes chemical injury around the stem or the calyx and sometimes at the lenticels as well. It is shown by the effect on the skin, which in the case of apples becomes dry and papery, tightly stretched but seldom cracked, and is often torn loose from the underlying fleshy tissue. The color is yellowish or brownish yellow, except when a considerable quantity of soluble arsenic is present, in which case the color becomes dark brown or black. Alkali injury on pears is most often shown by dark spotting at the lenticels. Very careful rinsing will reduce this form of injury to a minimum and should make it of no practical significance, except on pears, for which the use of alkaline washes is not recommended.

In some of the early types of washing machinery involving deep submersion of the fruit or the application of the solution in direct jets, some injury was caused by the penetration of the solvent into the core through open calyx tubes. Submersion to a depth of 4 to 6 inches may also result in penetration in some cases. This chemical injury is frequently followed by decay at the core. Open calyx tubes are more prevalent in certain varieties of apples and in very large fruit.

When apples are submerged in solutions warmed to 100° F. or higher for periods of three minutes or longer there is considerable danger of their injury. The results of such injury usually appear within 10 days or two weeks, in the development of cracks around the calyx, often continuing on to the cheek; or the injury may appear soon after washing in the form of numerous cracks scattered over the surface of the apples, particularly if a relatively high acid or alkali concentration has been used in the washing solution. The cracked skin is usually grayish or yellowish in color, resembling hydrochloric-acid injury, but is blackened if considerable soluble arsenic is dissolved in the cleaning solution. Apples are somewhat more susceptible to this type of injury at the time of harvest than after being kept for several weeks. None of the successful commercial washing machines requires exposure of the fruit for a period long enough to cause heat injury, but there is some danger of such injury when homemade washing equipment is used.

By keeping the temperature of the cleaning solution at 100° F. or below and preventing excessively long exposure to warm acid, danger of heat injury can be eliminated.

Aside from the rots which may follow penetration of the cleaning solution into the core, or those occurring as a result of chemical or heat injury, loss from storage rots may be somewhat greater on washed fruit owing to the extra handling to which it is subjected. The most important factor in preventing loss from storage rots is careful handling of the fruit to avoid bruising or puncturing the skin. The hazard can also be reduced by drenching the fruit with copious quantities of fresh rinsing water as it leaves the washing machine.

It is the general conclusion of those familiar with the removal of arsenical spray residue from apples and pears that if the washing is done with proper equipment and with proper care, under desirable sanitary conditions, neither the market value nor the keeping quality of the fruit will be impaired; on the contrary, both are frequently enhanced.[2]

---

[2] For further information on the relation of washing operations to fruit injuries, the reader is referred to Technical Bulletin 245, Arsenical and Other Fruit Injuries of Apples Resulting from Washing Operations, issued by the United States Department of Agriculture.

TYPES OF WASHING EQUIPMENT

If large quantities of fruit are to be cleaned under commercial conditions, it is generally advisable to purchase a commercial washing machine. These may be obtained in capacities ranging from about 400 to 3,000 boxes or bushels per day. Their cost will vary with the location and installation, but may be expected to range from about $700 to $1,800 without freight charges. Information about them may be obtained directly from their manufacturers. Two types of commercial machines are shown in Figures 3 and 4.

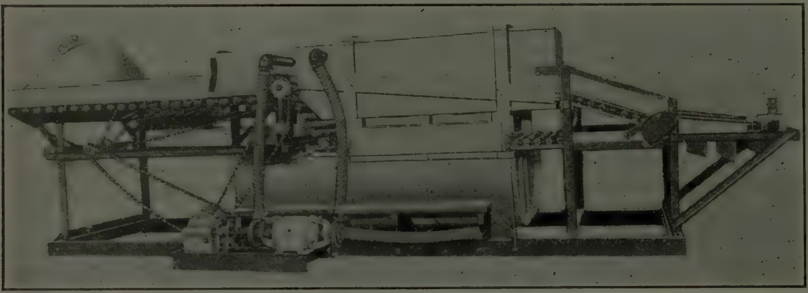


FIGURE 3.—A commercial fruit-washing machine

Where smaller quantities of fruit are to be handled, as by a grower washing his own crop, two types of washing equipment, the paddle washer and a pair of dipping tanks, have been successfully used for several years. The following paragraphs describe the construction and operation of such equipment. The total cost, of course, will vary with local differences in cost of material and labor and may be reduced by using idle pieces of machinery or equipment often found on the farm.

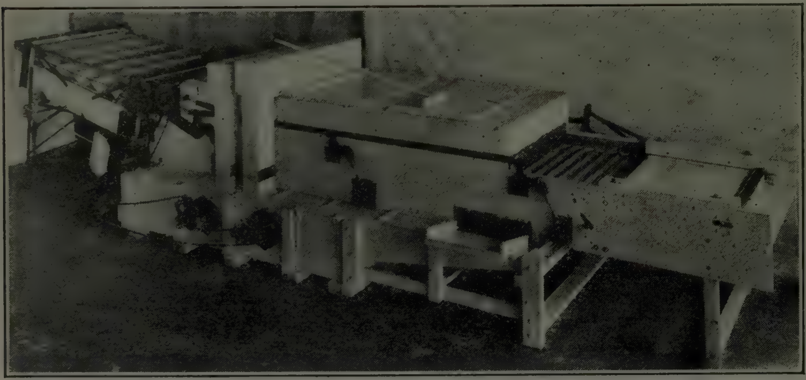


FIGURE 4.—Another type of commercial washing machine

PADDLE WASHER

A power-driven fruit washer, simple enough in construction and low enough in cost to be practical for the grower with a small fruit tonnage, is shown in Figure 5. Plans for its construction are given in Figures 6 and 7. This machine is a modification of the citrus

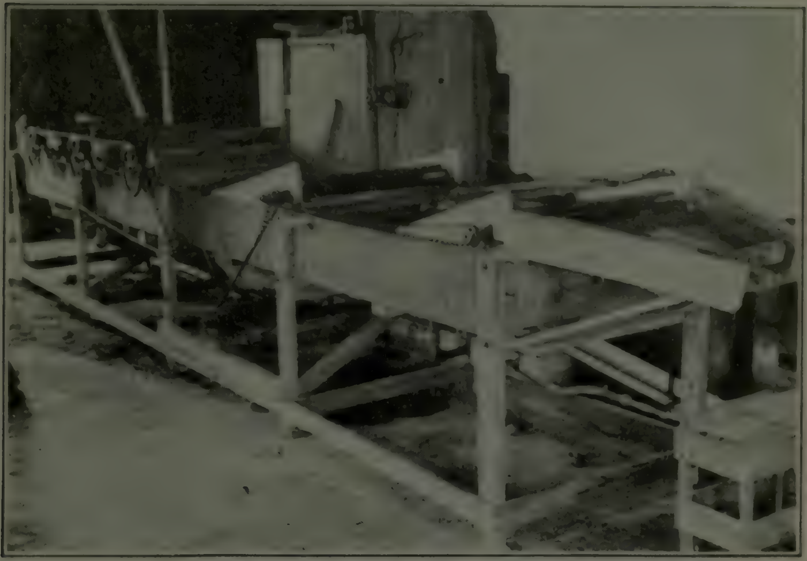


FIGURE 5.—Modified paddle washer

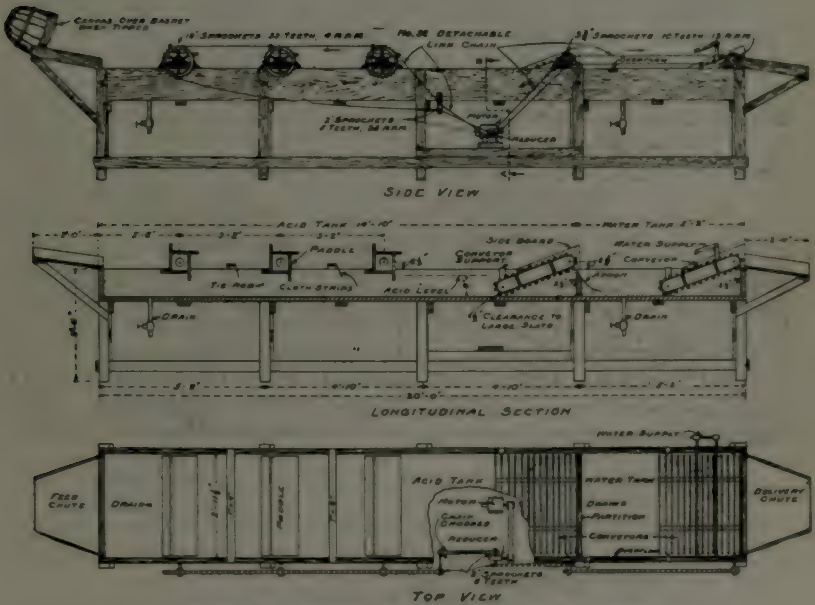


FIGURE 6.—Drawings of modified paddle washer

washer designed by the United States Department of Agriculture in 1925, and differs from the adaptation of that washer by the Oregon Agricultural Experiment Station (Circular of Information No. 15) in using conveyors instead of paddles to take the fruit from the tanks. Short lengths of conveyors in place of lift paddles are slightly more expensive, but the elimination of the binding and catching caused by these paddles, as they are often constructed, is well worth the additional cost.

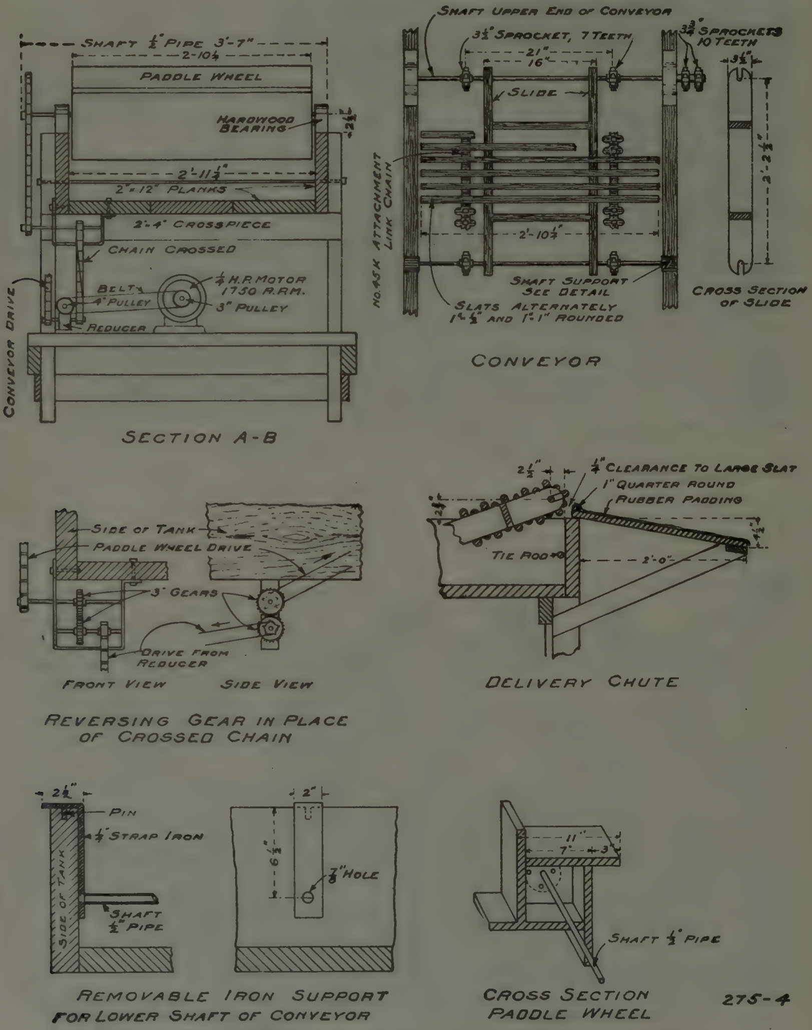


FIGURE 7.—Details of construction of modified paddle washer

CONSTRUCTION OF CONVEYORS

Paddle-type washers can be easily modified by removing the lift paddles and installing the lengths of slatted conveyors shown in the plans. The width of the conveyors will depend upon the inside dimensions of the tank. The drive for the conveyors will obviously have to be in the reverse direction from that used for the paddles, but this change can be accomplished by using a pair of reversing gears or by crossing the chain as indicated in the drawings in Figure 7. The conveyor shown is about the shortest that will satisfactorily remove the apples from the tank. Machine bolts, nuts, and washers are desirable means of attaching the hardwood slats so that they can be removed easily. Iron bolts, nuts, and washers will last longer in the acid than those made of brass. If the sprockets for this part of the equipment, and the driving mechanism as well, can not be procured from the factory with the face of the teeth beveled to about 30°, they should be ground before installing. If the teeth are left square, the chain will hang to the sprockets, especially on the smaller sizes, resulting in a great deal of trouble in driving them. In making the slide around which the conveyor moves, a slot should be made for the upper shaft in the side boards, as indicated also in Figure 7, to facilitate putting the conveyor in place.

The distances from the center of the upper shaft to the top and to the end of the tank are important in delivering the fruit from the ends of the conveyors. These distances as shown should be 2¾ inches from the top and 4 inches from the end of the tank. A piece of automobile tire inner tubing stretched at an angle from the end of the conveyor into the rinse tank will roll the fruit toward the end of the other conveyor and thereby reduce the chances of its being bruised by falling from the end of the conveyor on to fruit floating beneath in the rinse water. A chute made of ⅞-inch boards resting on a ⅞-inch crosspiece that is nailed to the top of the tank gives about the right height for delivering the apples from the conveyor. A piece of 1-inch quarter-round molding nailed across the end of the chute, clearing the largest cleat by a quarter of an inch, will aid in rolling the apples from the end of the conveyor with a minimum of bruising. A pitch of about 2½ inches in 2 feet will keep the fruit rolling on the chute. The piece of molding and the chute should be well padded with inner tubing or other material. The lower shaft of the conveyor is hung from the sides of the tank with iron stripping and held in place by pins which fit into holes in the sides of the tank. This method of holding the conveyors enables them to be raised from the tanks when not in use, thus reducing the corrosion from the acid and water, and facilitates cleaning the tanks. The clearance from the bottom of the tank to the large slats on the conveyor should be about one-half inch. A conveyor speed of 10 to 15 feet per minute will remove the fruit from the tanks fast enough to prevent its piling up.

The approximate cost of material for one conveyor is about $12 to $14, including chain, sprockets, slats, screws, and shafts.

CONSTRUCTION OF TANKS AND SUBMERGER PADDLES

The tanks are conveniently made of 2 by 12 inch material, with the acid tank 15 feet and the rinse tank 5 feet long, making a length over all of about 24 feet, including both feeding and delivery chutes. The machine described is only three boards wide, but if a larger capacity is needed, adding one or two boards to the width will increase the cost only slightly and will increase the capacity one-third and two-thirds, respectively. By using bolts and cross braces, as indicated in Figure 7, the tank can be drawn together. The edges of the boards should be first painted with asphalt paint to give tight seams. If the inside of the tank is painted, asphalt and not lead paint should be used, as the acid attacks lead. The shafts for the conveyors and submerger paddles are made of ½-inch pipe. Electrical conduit pipe is slightly cheaper than regular black iron or galvanized-iron pipe. This dimension refers to the inside diameter of the pipe, the external diameter being slightly less than seven-eighths of an inch. The shafts for the submerger paddles and those for the driving end of the conveyor are 43 inches long. A convenient and economical way to fasten the submerger paddles to the shaft is with floor flanges for rail fittings, which are procurable at any plumbing shop. Those made for ¾-inch pipe will fit over the ½-inch pipes and can be fastened to them by driving a pin in a hole drilled through the collar of the flange and the pipe.

The machine as shown is 42 inches high. This height is adapted to the usual height of graders, but the tank may be somewhat high if the fruit is dumped into it by hand. The capacity of the acid tank in the machine constructed according to the accompanying plans is about 210 gallons when filled to the recommended depth of 8 inches, while the rinse tank holds about 70 gallons. The fresh-water spray on the end conveyor is a very important feature and should supply from 2 to 3 gallons of fresh water per bushel or box of fruit washed. The cloth strips hung across the rinse tanks should preferably be made of heavy cloth and should be about 2 inches wide and long enough to allow about 3 inches to hang on the fruit as it is floated through the tank, thus turning it as the cloths cling to the apples while they move. These strips add to the efficiency of the machine by giving the fruit a longer and more complete exposure to the acid and are of some value in removing insect specking, dirt and lime-sulphur residue.

DRIVING MECHANISM

The sprockets, pulleys, and speeds shown in the plans are based upon a motor speed of 1,750 revolutions per minute with a 60-cycle current. If a 25-cycle current is used, giving 1,450 revolutions per minute motor speed, approximately the same speeds can be obtained with the driving mechanism shown by using a 3½-inch pulley on the reducer instead of a 4-inch pulley. A ¼-horsepower motor has been found large enough to run this machine. The reducing gear used, although smaller than recommended, transmitting only one-sixteenth horsepower, gave no signs of wear in a test run of about a month. A larger unit equipped with ball or roller bearings and transmitting one-fourth horsepower would provide a desirable margin of safety in operating the machine season after season. The gears and bearings must be kept well oiled. While the reduction in speed can be made by using a combination of sprockets or pulleys, the reduction gear will be about as economical when the installation of extra shafts and the cost of the additional gears or sprockets are considered. The diameter, the number of teeth, and the speed of the sprockets and pulleys are shown in the plans. The change in speed produced by the use of different sizes of sprockets or pulleys is of course in proportion to the number of teeth or in proportion to the diameters of the pulleys. The specifications and approximate cost of the driving equipment are given in the list of materials. No. 32 chain is used for driving, while the conveyor chain is No. 45–K–1 attachment link chain. All sprockets are equipped with set screws instead of keys.

If a gasoline engine is used as a source of power, a combination of sprockets or pulleys can be used to obtain the proper speed reduction.

CAPACITY

When built according to the accompanying specifications, the machine has a capacity of about 80 bushels an hour when the fruit is left in the acid solution for three to four minutes, which is about the desired time for most fruit. If the fruit is fed into the machine faster, more can be washed in a given time, the rate of feeding regulating the time in the acid and the resulting capacity. Increasing the speed to more than 80 bushels an hour is not recommended, and the machine should be built wider if it is anticipated that this capacity will not suffice.

COST

The material and equipment for the entire paddle-washer machine will cost about $100, including the motor and reducing gear. One carpenter should be able to build the tank and submerger paddles in about three days. The time necessary for putting the conveyor together and installing the driving mechanism will depend upon the mechanical ability of the individual, but the mechanism is simple enough to offer no great difficulty if the specifications are followed.

LIST OF MATERIALS

Lumber

5 pieces 2 by 12 inches by 20 feet long, for tank sides and bottom.
3 pieces 2 by 12 inches by 3 feet long, for tank ends and partition.
10 pieces 2 by 4 inches by 3 feet 6 inches long, for legs.
8 pieces 2 by 4 inches by 3 feet 7 inches long, for cross braces to tank.
4 pieces 1 by 4 inches by 10 feet long, for bottom leg braces.
2 pieces 1 by 4 inches by 3 feet 7 inches long, for bottom leg braces.
5 pieces 1 by 4 inches by 4 feet 4 inches long for cross braces for legs.
4 pieces 1 by 4 inches by 2 feet 6 inches long, for conveyor slides.
2 pieces 1 by 4 inches by 3 feet 7 inches long, for holders for cloth strips.
12 pieces ⅞ by 10 inches by 2 feet 10 inches long, finished, for submerger paddles.
4 pieces 1 by 6 inches by 2 feet 6 inches long, for conveyor guards.
6 pieces 1 by 6 inches by 6 inches long, for submerger paddle ends.
10 pieces 2 by 4 inches by 4 inches long, hardwood, for bearings.
40 pieces 1 by 1 inch by 2 feet 10 inches long, hardwood, for conveyor slats.
40 pieces 1 by ½ inch by 2 feet 10 inches long, hardwood, for conveyor slats.
Total cost of lumber (Washington, D. C., prices)______________ $17.00

Hardware, etc.

½-inch tank bolts, 3 feet 7 inches long, 3 at 35 cents	$1.05
Pipe for shafting, 3 feet 7 inches long, 5 pieces at 6 cents a foot	1.08
Pipe for shafting, 2 feet 11 inches long, 2 pieces at 6 cents a foot	.35
Pipe for shafting, 10 inches long, 1 piece at 6 cents a foot	.06
¾-inch cast-iron pipe flanges, 6 at 6 cents	.36
No. 8–32 iron machine screws, 1 inch long, 2 gross at 75 cents	1.50
No. 8–32 iron machine screws, 1½ inches long, 2 gross at 95 cents	1.90
Washers for screws	.25
Driving mechanism:	
No. 32 detachable driving chain, 50 feet at 10 cents a foot	5.00
No. 45–K–1 attachment link chain for conveyor, 22 feet at 25 cents a foot	5.50
Sprockets:	
For No. 32 chain, solid, set screw—	
12-inch sprockets, 33 teeth, ⅞-inch bore, 3 at $3.25	9.75
3¾-inch sprockets, 10 teeth, ⅞-inch bore, 3 at $1.75	5.25
2-inch sprockets, 5 teeth, ⅞-inch bore, 3 at $1.35	4.05
2-inch sprockets, 5 teeth, ½ or ¾ inch bore, depending on size of reducer driving shaft, 2 at $1.35	2.70
For No. 45–K chain, solid, set screw—	
3½-inch sprockets, 7 teeth, ⅞-inch bore, 8 at $1.70	13.60
Speed-reduction gear, 48–1 or 50–1 reduction with 4-inch or 3½-inch pulley, depending on motor speed of 1,750 or 1,450 revolutions per minute, respectively; cost $14 to $40, depending on size and make	25.00
Total estimated cost of material and equipment	94.39

The speed-reduction gears of the larger size have driving shafts of ¾-inch diameter, while the size transmitting one-sixteenth horsepower has a ½-inch driving shaft. In ordering the sprockets for this part of the driving mechanism, the specification of their bore should not be overlooked.

The chain, sprockets, and speed-reduction gears can usually be obtained through a local dealer in hardware or farm machinery. Because of possible delays in getting the material shipped and difficulties that may arise in making the machine, orders should be placed in ample time and the construction of the machine begun some time in advance of the packing season.

DIPPING TANKS

Dipping tanks are fairly satisfactory as homemade devices for washing pears. They are not recommended for apples except in an emergency when fruit must be washed quickly and no other equipment is immediately available or if a grower has only a small quantity of apples to wash. The paddle washer previously described is recommended as a homemade washer for apples. The saving in labor and the additional margin of safety that it provides more than compensate for its slightly greater cost.

If a considerable proportion of the apples have open calyx tubes, dipping tanks are not recommended unless they are modified to include an overhead spray or sluicing of liquid which makes it possible to lower the level of the liquid in the tanks.

As shown in Figure 8, the dipping tank installation consists of two similar tanks, one used for the acid solution and the other for the rinsing bath. Putting the tanks together with a spline is an excellent method of making them waterproof. Since the edges of the boards must be finished, the grooves can be cut at the mill with little extra cost. Three-eighths-inch bolts are used to draw the tanks together; they are fastened through the legs below the tank for the horizontal pressure and through 2 by 4's across the top and bottom of the tank for vertical pressure. Asphalt paint should be used on all seams and joints, because it is acid-proof as well as waterproof.

The drain board should slope toward the acid-solution tank. Its floor is made of pieces 1 by 6 inches, laid flat. Strips 1 by 2 inches are nailed lengthwise on this floor every 6 inches, so that the liquid will flow back freely into the acid-solution tank. A similar drain board can be made at the end of the rinse tank, long enough to accommodate at least two boxes. The slides at the ends of each tank aid in getting the boxes into and out of the tanks and are conveniently made of pieces 2 by 4 inches, laid on edge.

Some device for slightly submerging the boxes of fruit as they pass through the tanks will obviate the necessity of doing it by hand. Two boards can be placed lengthwise in the tanks at the acid-solution level, and if fastened to the crosspiece at the feeding end of the tank by means of hinges their weight will suffice to keep the boxes slightly submerged as they are pushed through. When the modification of the dipping tank described in a following paragraph (p. 30) is used, with an overhead spray or sluice of liquid on the fruit, submerging the boxes in the acid solution is obviously not necessary.

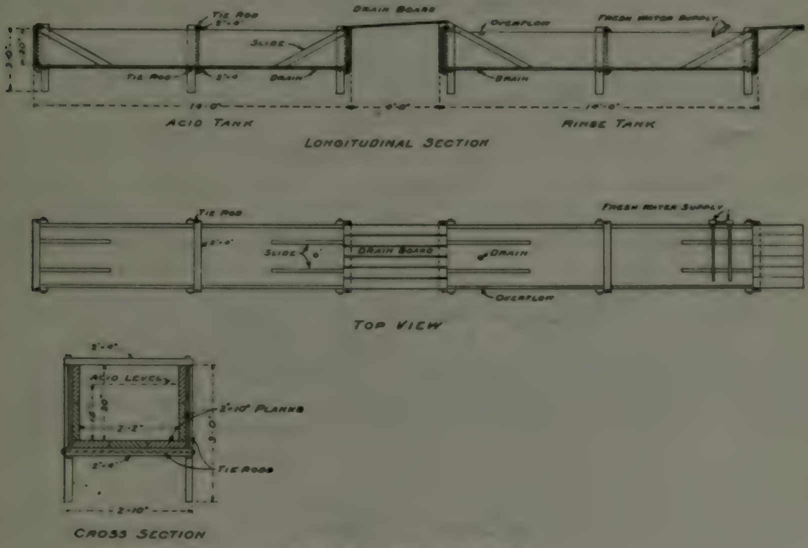


FIGURE 8.—Dipping tanks

Ordinary apple boxes with slatted sides and fitted with easily removable covers are good containers to use in the tanks. If the washing is done in the picking boxes or lugs, extra handling of the fruit is eliminated, thus reducing the labor required and minimizing the danger of injury to the fruit. If covers are used, they should be removed when the boxes or lugs reach the end of the rinse tank, where the fresh-water spray is located.

An exposure of from three to five minutes in the acid-solution tank and a similar period in the rinse is recommended for cleaning lots of fruit bearing average amounts of spray residue. The depth of the liquid in the tank should be about 15 inches when the tank is filled with boxes of fruit. Fresh water should flow into the rinse tank by means of a spray or should flood over the fruit as it leaves the rinse tank. From 2 to 3 gallons of fresh water should be supplied for every box of fruit washed.

CAPACITY

The dipping-tank equipment described has a capacity of more than a carload a day, allowing for an exposure of each box of fruit for three or four minutes in the cleaning solution and the same period of time in the rinse tank.

COST

The material and labor for making the dipping tanks will cost from $30 to $70, depending on local prices for lumber and labor.

LIST OF MATERIALS

Lumber

14 pieces 2 by 10 inches by 14 feet long, finished, for tank sides and bottom.
8 pieces 2 by 10 inches by 2 feet 2 inches long, for tank ends.
12 pieces 2 by 4 inches by 3 feet long, for tank legs.
12 pieces 2 by 4 inches by 3 feet long, for cross braces on tank.
8 pieces 2 by 4 inches by 4 feet long, for slides in tank.
2 pieces 2 by 4 inches by 3 feet long, for end drain-board braces.
6 pieces 1 by 6 inches by 4 feet 6 inches long, for center drain-board floor.
6 pieces 1 by 6 inches by 3 feet long, for end drain-board floor.
7 pieces 1 by 2 inches by 4 feet 6 inches long, for center drain-board strips.
7 pieces 1 by 2 inches by 3 feet long, for end drain-board strips.

Hardware

6 ⅜-inch rods, 3 feet long, with nuts and washers, for horizontal tank braces.
12 ⅜-inch rods, 2 feet 2 inches long, with nuts and washers, for vertical tank braces.
1-inch pipe for fresh-water spray.

MODIFICATIONS

If it is more suitable to the packing operations the tanks can be set up beside each other instead of end to end, and the drain board can be placed across their ends.

Pumping the acid solution into pipes or a sluice box over the washing tank and letting it flow over the fruit, mostly by gravity, has been found particularly helpful in increasing cleaning efficiency where electric power is available to operate the pump. This method combines a dipping treatment with a modified spray or flood wash. A small centrifugal pump such as is used for filling spray tanks will serve the purpose.

Where pipes are used, holes may be bored in them to allow the solution to flow over the fruit, or nozzles of various forms may be used. Where the sluice box is employed, slots or holes bored in its bottom will serve the purpose. In either case a screen should be placed over the pump intake so that leaves, twigs, and sediment in the washing solution will not clog the pump or the openings for the liquid. An important advantage of this modification of the dipping tank is that pumping the liquid out of the tank and directing it over the fruit reduces the depth of the cleaning solution in the tank and thus lessens the danger of core penetration by the solution, without sacrificing any cleaning efficiency.

Moving the boxes of fruit through the tanks has been facilitated by using ordinary roller conveyors, the acid solution not affecting them enough to prohibit their use. Belt conveyors driven by electric motors also have been used to carry boxes through the tanks.

Another modification of the dipping tank has been made by increasing the width of the tank to give room for the installation of power-driven longitudinal paddles which throw acid into the boxes of fruit as they are pushed through on roller conveyors submerged about 8 inches. This method of getting the acid on the fruit is employed by one of the manufactured machines, and application has been made for a patent covering its use.

COST OF REMOVING SPRAY RESIDUE

While the cost of washing fruit will vary, of course, with the section of the country in which it is done, as well as with the washing method, the tonnage of fruit, the packing arrangements, and the character of the spray residues on the fruit, it may be helpful to indicate such costs approximately.

In the Pacific Northwest the cost of washing a box or bushel of fruit will range from 1 to 2 cents for hand dipping in small lots and 2 to 3 cents for the paddle washer to 3 to 4 cents for washing moderate tonnage in the commercial machines, with a proportionate reduction per box as the tonnage is increased and the overhead costs are distributed over a greater number of boxes.

Under eastern conditions the cost per bushel has generally been from 1 to 5 cents, with 2 to 2½ cents as a fair average. The cost of washing decreases as the amount of fruit handled increases; it also depends on the initial cost of the machine. The cost of washing 5,000 bushels with a small commercial machine would be about 5 cents a bushel, 2 cents with a paddle washer, and 2¾ cents for hand dipping. For 15,000 bushels the costs per bushel would be about 2¼ cents for the commercial machine, 1 cent for the paddle washer, and 2½ cents for hand dipping. Except in the case of hand dipping, the cost of labor is not materially increased because of washing. In arriving at the foregoing estimates, interest and depreciation on the investment, maintenance, and cost of water, power, and materials were considered.

While no actual cost estimates for dry-cleaning fruit are available, such figures as have been calculated from time to time have indicated that washing fruit is a more economical as well as a more efficient method of removing arsenical spray residues from apples and pears.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	ARTHUR M. HYDE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel and Business Administration.	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Solicitor	E. L. MARSHALL.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	R. Y. STUART, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Plant Quarantine and Control Administration	LEE A. STRONG, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*

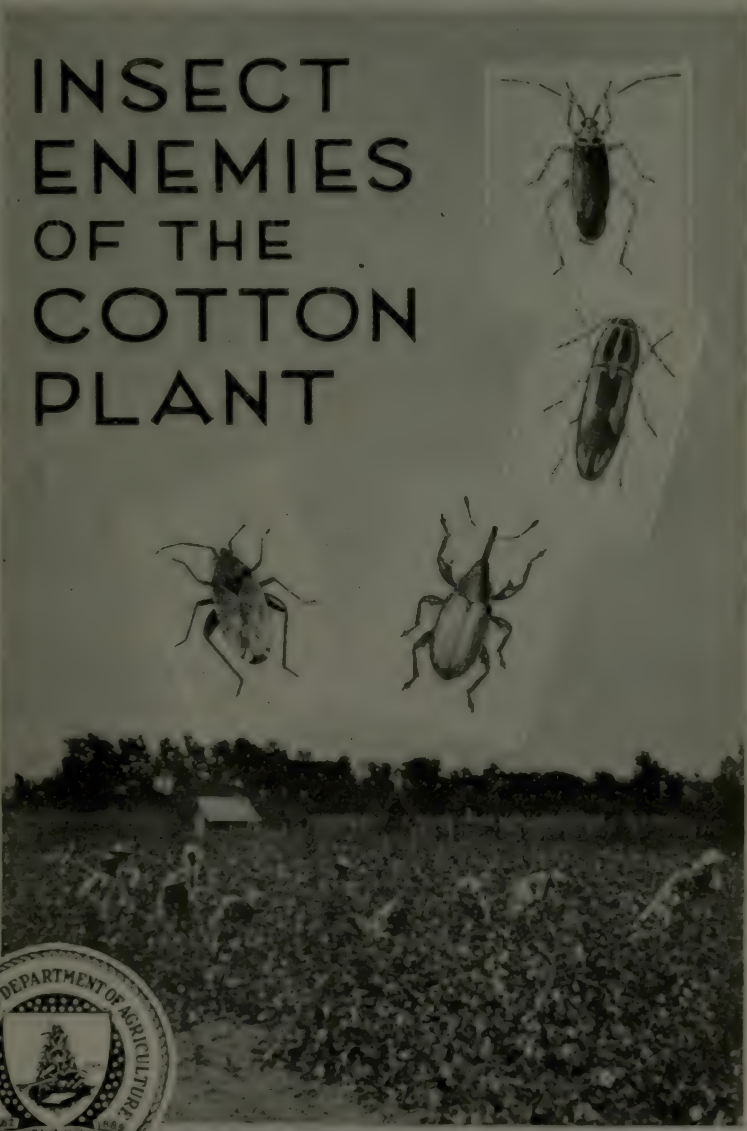
U. S. GOVERNMENT PRINTING OFFICE: 1931

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1688

INSECT ENEMIES OF THE COTTON PLANT



1862 1889

THE COTTON PLANT is unusually attractive to insects and probably no other cultivated crop has so large a list of insect enemies. Among these are some of the most destructive pests of agriculture.

Rotation of crops is of assistance in controlling many cotton pests. Weeds should not be allowed to grow near the cotton, for many pests come to the cotton from other crops or from weeds around the fields. Thorough fall plowing, winter cover crops, early spring preparation, and repeated cultivation during the season are important measures of insect control. An early crop is necessary.

The cotton plants should be turned under in the fall—if possible, before frost.

This bulletin describes many cotton insects and their work, and gives suggestions for their control. A system of control effective against most of the insects referred to is given in summary form at the close of the bulletin.

This bulletin is a revision of and supersedes Farmers' Bulletin 890, How Insects Affect the Cotton Plant and Means of Combating Them.

Washington, D. C. **Issued July, 1932**

INSECT ENEMIES OF THE COTTON PLANT

By J. W. Folsom, *Senior Entomologist, Division of Cotton Insects, Bureau of Entomology*

CONTENTS

Page
Insect cotton pests of greatest importance ... 1
  The boll weevil ... 1
  The Thurberia weevil ... 4
  The cotton leaf worm ... 4
  The bollworm ... 6
  The cotton flea hopper ... 7
  The cotton aphid ... 9
  The pink bollworm ... 11
  The cotton leaf perforator ... 14
  The red spider ... 15
Miscellaneous insect pests of cotton ... 16
  The cotton square borer ... 16
  The yellow-striped army worm ... 17
  The cotton stainer ... 17
  The cotton plant bug ... 18
Miscellaneous insect pests of cotton—Contd.
  The tarnished plant bug ... 18
  The cotton dauber ... 19
  The garden webworm ... 19
  The salt-marsh caterpillar ... 20
  The fall army worm ... 20
  The cowpea curculio ... 22
  May beetles ... 23
  Grasshoppers ... 23
  Cutworms ... 24
  Sharpshooters ... 24
  The corn root aphid ... 25
  Wireworms ... 25
General considerations ... 26
Summary of control measures ... 27

TO CARRY ON successfully the inevitable and incessant war against insect enemies of his crop and his income, the cotton grower must be able to recognize each of the more injurious cotton pests and its work when he sees them and must know how each pest can be controlled.

Although the cotton plant is highly attractive to insects and has a long list of insect enemies, not all of the insects found in the cotton field are there as a menace to the cotton plant. Some of them feed on the pests themselves and others exist without damaging the crop.

The worst insect enemies of the cotton crop as a whole—those that appear most often and do the most damage when they do appear—constitute the group which will be discussed first in this publication.

INSECT COTTON PESTS OF GREATEST IMPORTANCE

THE BOLL WEEVIL

In the United States the boll weevil (*Anthonomus grandis* Boh.) has in some years caused a loss in the cotton crop of more than $200,000,000. The weevil now covers almost the entire main Cotton Belt, where the necessity of combating it has revolutionized the methods of cotton production.

The insect (fig. 1) winters as an adult in sheltered places. The weevils that survive the winter emerge from hibernation over a long period, usually from about March 1 to about July 1, and attack squares and young bolls, although preferring the former.

In these they make punctures for feeding or for egg laying. Punctured squares flare open conspicuously (fig. 2) and usually fall to the ground in a few days. A large number of squares are shed naturally, of course, and additional shedding may be caused by weather conditions or careless cultivation. Immature weevils die quickly in the shed bolls; in fact, heat and dryness are important natural controls of the boll weevil. A puncture made by a weevil in feeding remains open, but an egg puncture is sealed with a wart-like plug. The egg hatches in about 3 days into a stout white larva, with a head but without legs. (Fig. 3, left.) This larva feeds inside a square or boll, becomes full grown in from 7 to 12 days, and passes from 3 to 5 days as a pupa (fig. 3, right), from which the beetle emerges. Small bolls drop if severely punctured. Larger bolls in which weevils are developing, may decay and dry up without opening, or may open and show one or more locks ruined by weevil attack. As the period from egg to adult is only from two to three weeks in length, there may be several generations of the weevil in a single season.

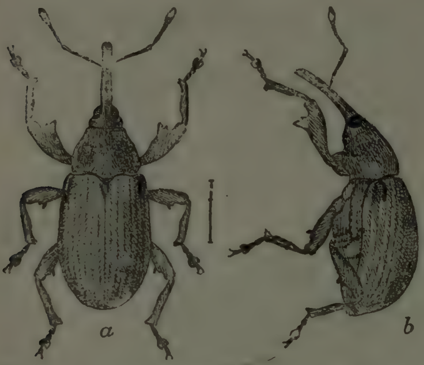


FIGURE 1.—Boll weevil adults: *a*, Viewed from above; *b*, from the side. About five times natural size. (Hunter and Coad)

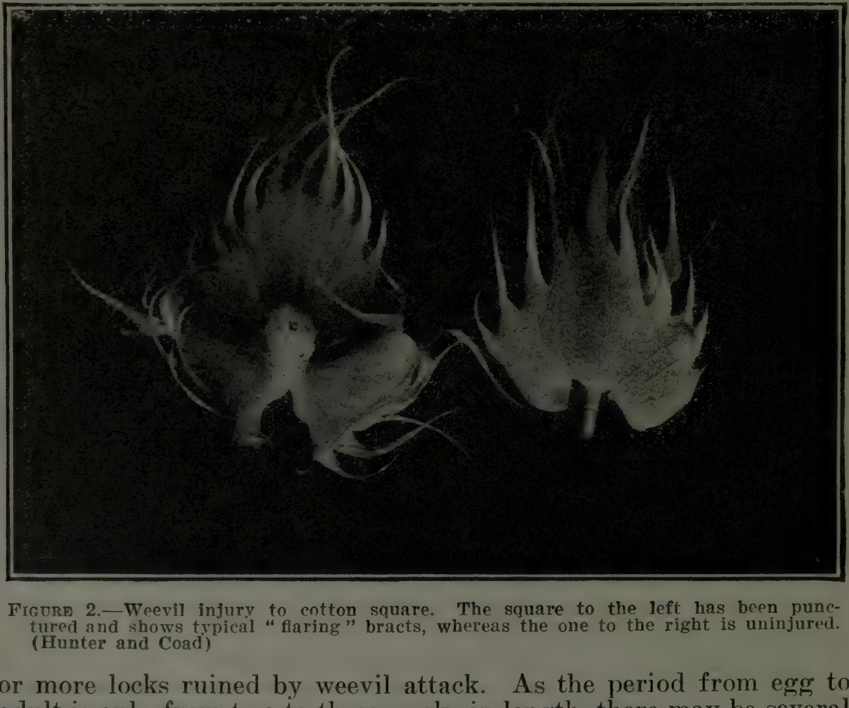


FIGURE 2.—Weevil injury to cotton square. The square to the left has been punctured and shows typical "flaring" bracts, whereas the one to the right is uninjured. (Hunter and Coad)

It is possible to control the boll weevil effectively and profitably.[1] The most approved method of direct control is to dust cotton plants with calcium arsenate, beginning as soon as 10 per cent of the squares have been punctured.[2] The poison should be applied, at the rate of from 4 to 6 pounds per acre, when the air is reasonably calm and the plants are moist. Three or more applications at 5-day intervals may be necessary to reduce the infestation to less than 10 per cent. Additional applications may become necessary later on. If a heavy rain falls within one day after dusting, repeat the application as soon as possible.

If overwintered weevils are unusually abundant in the field in early spring, an application of calcium arsenate dust before the plants begin to put on squares is advisable. Use from 2 to 3 pounds per acre. For this dust application shakers, bags, or the like may be used, or any type of dusting machine recommended for later applications, provided the nozzles are lowered sufficiently for the dust to reach the small plants. Or, a molasses mixture consisting of 1 pound calcium arsenate, 1 gallon of water, and 1 gallon of molasses, thoroughly mixed together, may be used. It is applied to the plants at the rate of 1 gallon per acre by means of a homemade rag mop, when the cotton begins to square.

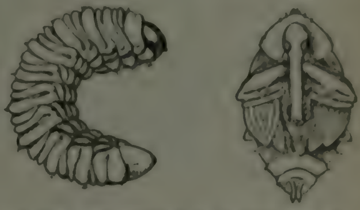


FIGURE 3.—Immature stages of boll weevil: Larva at left, pupa at right. About five times natural size. (Hunter and Coad)

When using dusting machinery employ only that which is specially constructed for cotton dusting.

Airplane dusting has many advantages, especially on large, level, open areas, and usually costs no more than dusting with ground machines.

In fighting the boll weevil it is most important to get as early a crop of cotton as possible—in other words, to get the crop beyond the square stage before the weevils have become sufficiently numerous to prevent the bolls from setting. This involves not only the selection of an early-maturing variety of cotton adapted to the locality, but also the plowing and working of the soil to prepare an early seed bed, planting as early as is safe, and stimulating plant growth by proper cultivation, with fertilization if necessary. The boll weevil places a premium on good farming.

Where conditions permit, after the cotton is picked the plants should be destroyed before the first killing frost by plowing them under or burning them. This is important. Cleaning up and burning dead weeds and other trash in winter reduces the number of hibernating weevils.[3]

---

[1] U. S. Dept. Agr. Leaflet 37, Poisoning the Cotton Boll Weevil.

[2] To determine when 10 per cent of the squares are infested, pick 100 squares from each of the four corners and from the center of the field—500 in all. If 50 of these squares are infested, it is time to start dusting.

[3] See Farmers' Bulletin 1329, The Boll Weevil Problem, and Farmers' Bulletin 501, Cotton Improvement Under Weevil Conditions.

THE THURBERIA WEEVIL

Although extremes of heat and dryness are fatal to the boll weevil, the variety known as the Thurberia weevil (*Anthonomus grandis* Boh., var. *thurberiae* Pierce) thrives in arid regions. This variety is a native of mountain ranges in southeastern Arizona, where it feeds on a species of wild cotton (Thurberia) which grows in the beds of canyons and along small washes. It breeds and passes the winter in bolls of this plant, almost always as a beetle. Infested bolls do not open and drop the seeds but remain almost closed, and many such bolls fall to the ground and are carried down to the plains by floods. After sufficient rains the bolls rot and release the beetles, which emerge commonly in July or August and may spread by flight. This weevil is known to occur in parts of five counties in Arizona. It is increasing in numbers in the cultivated sections and is now infesting some 12,000 acres of cotton, largely in the Santa Cruz Valley.

On the wild cotton the weevil has only one and a partial second generation annually, but when living on cultivated cotton it produces as many as three generations and winters in the bolls as a rule, though some beetles emerge and winter in other shelter. The numbers of such weevils may be greatly reduced by breaking down and burning old cotton stalks in the fall. This weevil in cultivated cotton may be controlled in the same way as the boll weevil.

Strict quarantine regulations are being enforced in the effort to restrict this weevil to the present infested areas. The regulations permit movement of articles likely to carry the weevil from points within the infested area to points outside only after compliance with adequate safeguards. These regulations give protection to all uninfested cotton-growing sections of the United States, either within Arizona or elsewhere.

THE COTTON LEAF WORM

Until the arrival of the boll weevil, the leaf worm (*Alabama argillacea* Hbn.) and the bollworm were our two worst cotton pests. The leaf worm is not known to survive the winter in the United States, but is a native of tropical or subtropical America. In some years the moths enter this country, usually through Texas, rarely through Florida, and multiply on cotton throughout the growing season, becoming more abundant with each generation, and spreading over the main Cotton Belt until they often reach the Northern States and even Canada.

The activity of the leaf worm varies greatly in different years, but this insect is injuriously abundant much oftener west of the Mississippi River than in the Southeastern States.

In southern Texas there may be at least seven generations of the insect annually. Early broods of worms, by destroying the leaves of the cotton plant, may prevent the bolls from maturing. Late broods not only " rag " the leaves (fig. 4) but may strip every plant in a field of its leaves and squares, gnaw into bolls and bark, and then crawl away in search of more cotton—their only food plant. The brown, defoliated field looks as if it had been swept by fire. The defoliation causes a premature opening of the bolls that results in a lower grade of cotton, and the lint is stained and further damaged by the excrement of the worms.

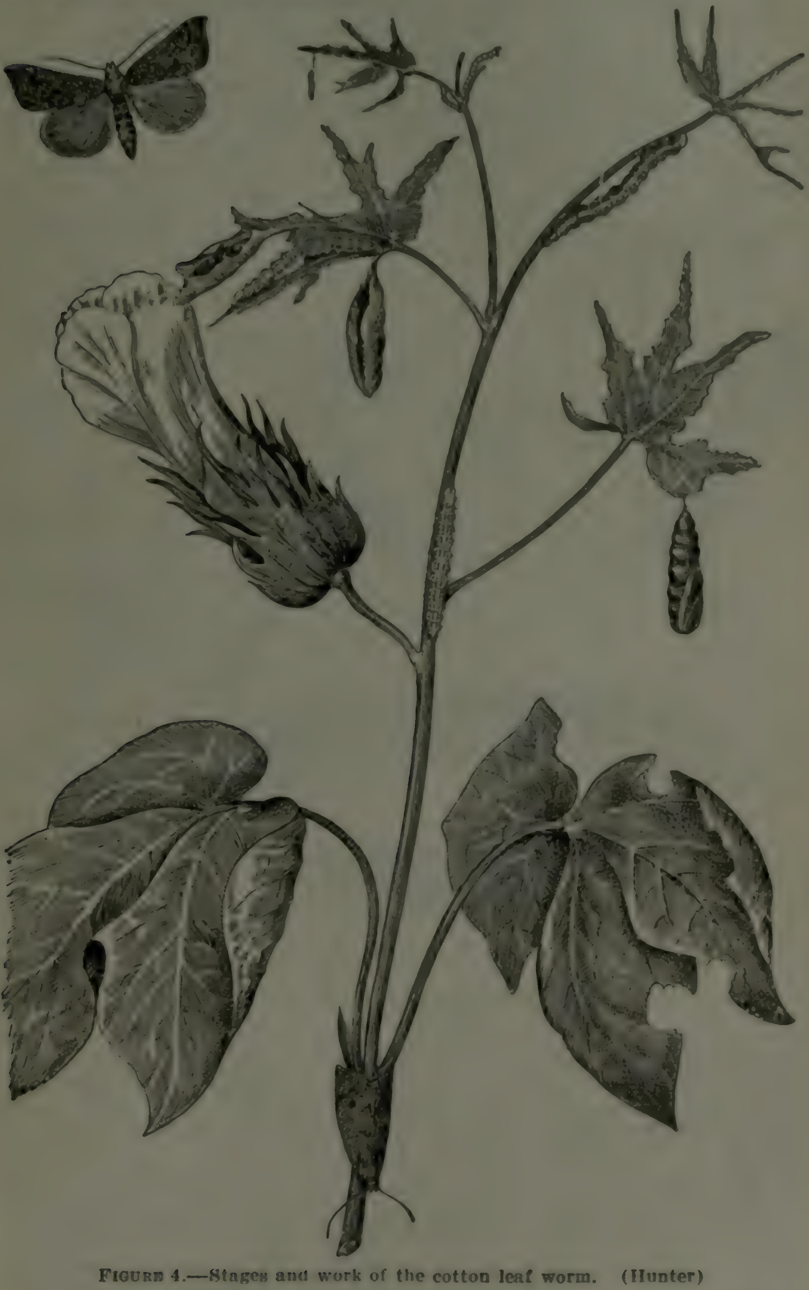


FIGURE 4.—Stages and work of the cotton leaf worm. (Hunter)

The caterpillars vary greatly in coloration, but each segment of the abdomen as seen from above shows four round black dots in the form of a square.

For the first few days after hatching, the worms feed on the undersides of leaves, not eating clear through a leaf, but leaving the upper skin. The spots thus made turn brown and are early indications that the worms are present. Later the worms move to the tops of plants to feed, and then are easily poisoned with arsenicals.

Calcium arsenate at the rate of 5 pounds or more per acre, applied in the same manner as for boll weevil control, is most effective when the worms are young and the infestation is beginning. With a heavy infestation of large worms the killing may be somewhat slow and a heavier dosage, or a mixture of calcium arsenate and Paris green, containing from 15 to 20 per cent of the latter, may be used. Paris green may be used also as in the following mixture: 1 part of Paris green, 1 part of flour for a sticker, and about 5 parts of lime to prevent burning. From 12 to 14 pounds of this mixture should be applied per acre. In emergencies other stomach poisons can be used, but they are usually not so satisfactory as those just named.

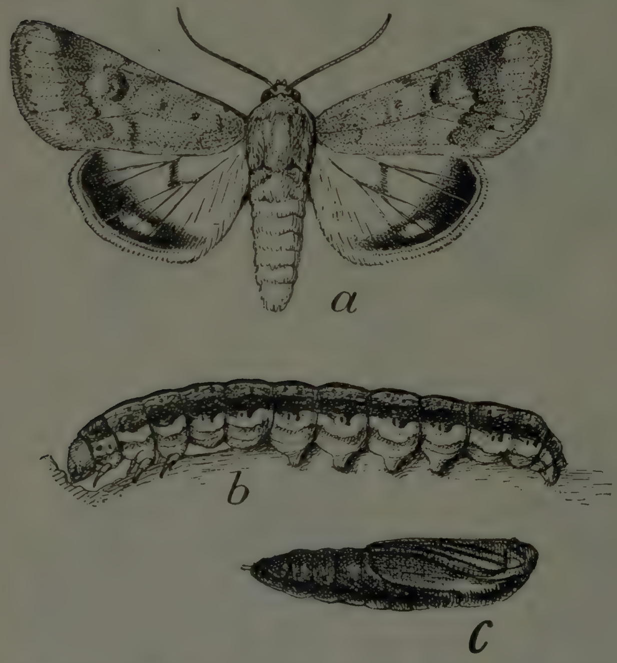


FIGURE 5.—Bollworm: *a*, Moth or adult; *b*, larva, or worm; *c*, pupa. About natural size. (Howard)

THE BOLLWORM

The bollworm (*Heliothis obsoleta* Fab.), known also as the corn ear worm and the tomato fruit worm, feeds on some 70 plants, but is most destructive to corn, cotton, tomato, and tobacco. Though it may severely damage cotton, its occurrence in any one district is very irregular. In the South early generations feed on field corn, and when this hardens in summer the moths lay their eggs on cotton plants. The caterpillars (fig. 5, *b*) feed only slightly on foliage. They attack the flowers or bore into squares or bolls and eat out part or all of the contents, and one caterpillar may injure several of these forms. Infested squares flare open and usually drop to the ground. By far the greatest loss caused by this insect, however, is due to its attacks on the bolls. When squares or bolls are not available the insect has the bad habit of cutting off the growing tips of cotton plants.

In the Cotton Belt there are from four to six generations of the bollworm each year. The insect winters as a pupa (fig. 5, *c*) in a cell a few inches below the surface of the soil.

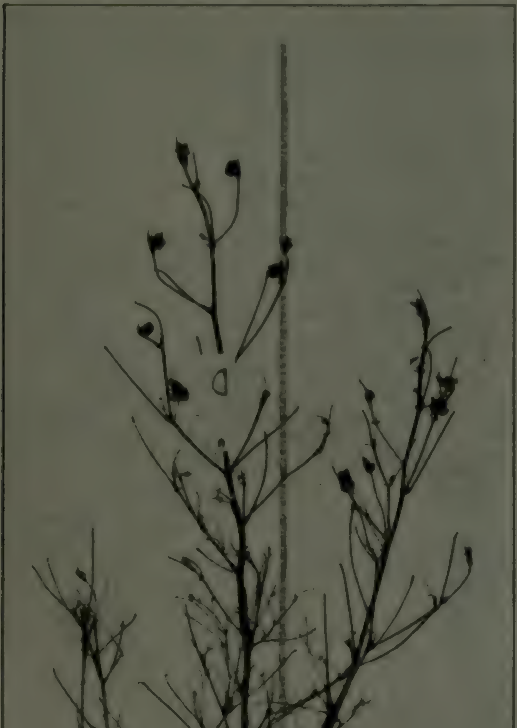


FIGURE 6.—Cotton plant deformed by the attacks of the cotton flea hopper. The leaves have been removed to show the characteristic branching due to the insect's attack

As older cotton bolls are less subject to attack than are the squares and younger bolls, efforts should be made to hasten the maturity of the crop, as in the case of the boll weevil. After picking, cotton stalks should be destroyed by plowing or by burning. Late fall or winter plowing destroys the pupae in the soil.

Dusting with calcium arsenate, as for the boll weevil, is recommended. The applications should be made from July 10 to August 20, according to latitude and other conditions.[4]

THE COTTON FLEA HOPPER

A peculiar disorder of the cotton plant, known for a third of a century, has in recent years been proved to be caused by the cotton flea hopper (*Psallus seriatus* Reut.) and a few other insects related to it. Usually the flea hopper has been the predominating species.

An alarming sign of this disorder is the failure of plants to produce blooms. This is due to the destruction of the very tiny squares by the punctures of the hopper. Punctured squares are blasted, turn brown or black, and fall from the plant. Another characteristic of hopper damage is the abnormal growth and branching of affected plants. (Fig. 6.) Branching of such plants is erratic, with many suckers or other surplus branches present, and often a few of the lower branches are abnormally large. After the hoppers have gone the plant sometimes becomes unusually tall. Less conspicuous, but also characteristic of hopper damage, are the wounds made by the punctures on stems, branches, and leaves before buds are available. Plant cells surrounding the punctures are killed. This effect is local, however, for there is as yet no evidence that any virus from the insect is transmitted through the plant.

---

[4] Farmers' Bulletin 1595, The Bollworm or Corn Ear Worm as a Cotton Pest.

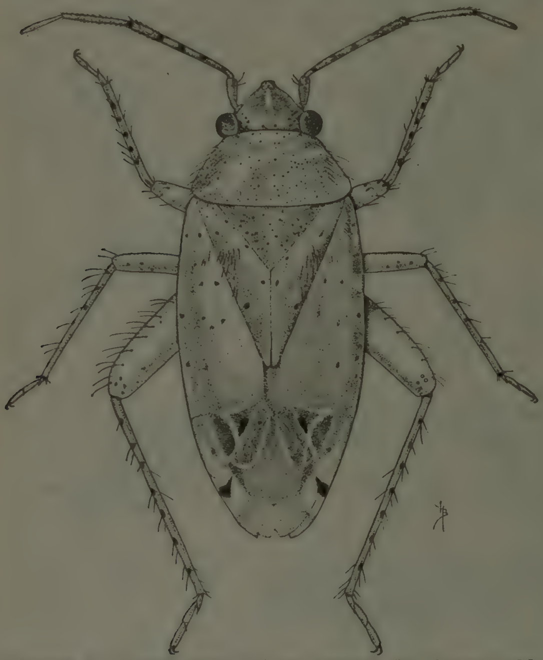


FIGURE 7.—Adult stage of the cotton flea hopper, 20 times natural size

Associated with the cotton flea hopper in the production of hopper damage, including scars and blasted squares, may be one or more of three other insects belonging to the same family, namely, the tarnished plant bug (p. 18), the cotton plant bug (p. 18), and a third species, *Creontiades debilis* Van D.

The adult hopper (fig. 7) is about one-eighth of an inch long, pale greenish or grayish, thickly dotted above with brownish spots, and with two pairs of characteristic black marks near the tip of each wing. The nymphs are green and wingless.

The hopper breeds on several species of goatweed (Croton), on horsemint, evening primrose, and many other weeds. The principal host plant is Croton, on which the hopper occurs throughout the year. Other plants are temporary hosts. Horsemint is a favorite food plant of the hopper in parts of Texas until the plant dries up in May or June, forcing the hoppers to migrate to cotton or other plants.

The hopper winters in the egg stage, the eggs being inserted singly under the bark of stems of Croton and many other kinds of weeds, and sometimes in cotton. The eggs hatch over a long period. At College Station, Tex., they are hatching from about February 15 to July 1, with the maximum emergence in the last week of March. At Tallulah, La., the period is from March 9 to June 1, with the peak of emergence in the last week of April. From Croton many of the hoppers go to the cotton plants. The young, or nymphs, probably are often carried by the wind.

As the life cycle of the insect, from egg to egg, takes only from two to four weeks, according to the time of year, there is an opportunity for the occurrence of from 6 to 12 generations annually, or an average of 9.

As a general practice, weeds in the vicinity of cotton fields should be destroyed. Croton or goatweed in particular should be eradicated by burning in late fall or in winter. Old cotton stalks should be destroyed, as they also may contain eggs of the hopper.

A method of control recommended at present is dusting with finely ground sulphur at the rate of 10 pounds per acre, when the air is reasonably calm. The presence of many blasted squares on the plants is an indication that dusting should begin. A second application should be made four or five days later, with such additional applications as may be necessary. Often two applications are sufficient. After the sulphur applications the disappearance of hoppers from a field is gradual, and freshly blasted squares may be found even as late as 12 days after hoppers have left the plants.

Where boll weevils as well as hoppers are prevalent, a combined application of 8 pounds of sulphur and 4 pounds of calcium arsenate per acre should be used.

Sulphur dust is highly inflammable and explosive. It should not be exposed to a flame of any kind and should not be applied to cotton with machinery operated by a gasoline engine, without extreme care.

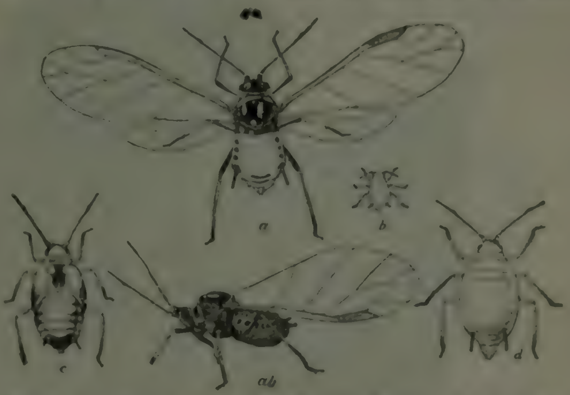


FIGURE 8.—Cotton aphid: *a*, Winged female; *ab*, dark female, side view; *b*, young nymph or larva; *c*, last stage of nymph; *d*, wingless female. Enlarged to 10 times natural size. (Chittenden)

THE COTTON APHID

The most abundant aphid on cotton plants is generally the cotton aphid (*Aphis gossypii* Glov.), also known as the cotton louse or melon louse. This cosmopolitan species feeds on a great variety of plants but is most injurious to melons, squashes, cucumbers, and other curcurbits, and to cotton and okra.

These aphids (fig. 8) vary greatly in coloration but are commonly green or greenish black, or yellow, with characteristic black markings.

In the South, full-grown females hibernate and in spring begin to reproduce. At this time, especially in cool weather, the aphids occasionally stunt, deform, or even kill seedling cotton.

They multiply at an extraordinary rate, except at extremely high temperatures. At times winged females appear and carry infestation to other plants. The aphids are commonly found on the lower sides of leaves (fig. 9); they may cause the leaves to curl and may retard the growth of plants. In a dry season plants sometimes shed their leaves as a result of aphid attack. After severe infestations the yield of cotton may be reduced by 50 pounds of seed cotton per acre, on the average, with 100 pounds per acre as the maximum reduction.

The aphids are constantly sucking sap from the plants; and the excess fluid passed through their bodies drops on the leaves or on the ground as a clear sticky substance known as honeydew, which often becomes infected with a sooty fungus and turns black. Honeydew falling into open bolls may stain the lint and make it gummy, thus lowering its grade.

Planters are often unduly alarmed by the presence of aphids on their cotton, but they may be reassured by the fact that the plant usually resists aphid injury successfully. A single heavy rain may wash most of the aphids from the plants, and in damp weather a common fungus disease immensely reduces their numbers. A great many kinds of insect enemies act as checks on the multiplication of the aphids. Of these, the lady beetles are among the most important. Their presence on a plant indicates that aphids are there also. Ants visit cotton plants to get honeydew from the aphids.

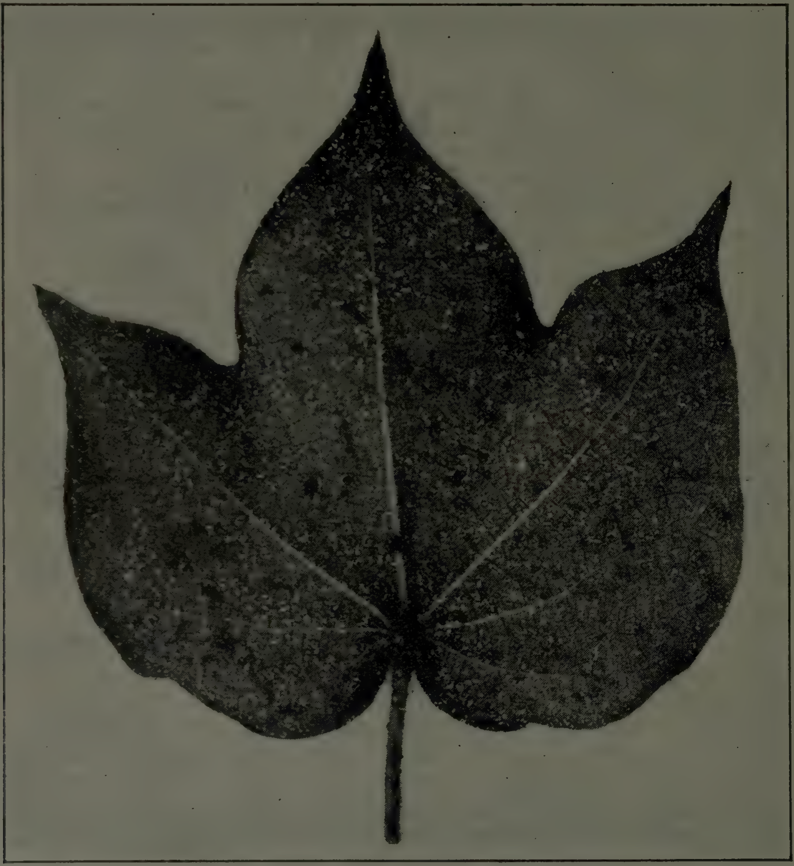


FIGURE 9.—Lower surface of cotton leaf showing heavy aphid infestation

Aphid infestation on cotton can easily be suppressed by applying, under proper conditions, a nicotine dust containing about 2½ per cent of nicotine. Usually one application is sufficient. The dusting should be done only when the air is calm, and becomes more effective as the temperature rises. A single dusting may be made to serve for both boll weevil and aphid by mixing that percentage of nicotine with the calcium arsenate. In other cases hydrated lime is used as a carrier for the nicotine.

To make this nicotine dust, thoroughly mix 100 pounds of the carrier with 6¼ pounds or 5 pints of commercial nicotine sulphate solution which contains 40 per cent of nicotine. Apply the dust at the rate of from 6 to 9 pounds per acre.[5]

As nicotine dusts deteriorate rapidly upon exposure to the air, it is well to make them at home, just before they are to be applied.

THE PINK BOLLWORM

The pink bollworm (*Pectinophora gossypiella* Saund.) is a destructive pest of cotton and occurs throughout practically all cotton-producing regions of the world except in the United States, where it is found only in limited parts of Texas, New Mexico, and Arizona. However, on a few occasions this destructive pest has entered, and for short periods become established in, limited areas in the eastern part of the main Cotton Belt. These infestations have been wiped out by eradication campaigns carried on cooperatively by Federal and State agencies and usually involving the maintenance of cotton-free zones.

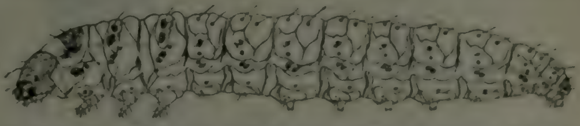


FIGURE 10.—The pink bollworm: Outline drawing of larva, showing structure. Enlarged to 6 times natural size. (Busck)

The occurrence of this dangerous pest in Mexico especially in the area along the Rio Grande, has resulted in its becoming established in the cotton-producing districts on or near the international boundary in the extreme western part of Texas and in certain valleys in New Mexico. Because of the menace that the pink bollworm presents to the cotton-producing areas in the United States, a strict quarantine is maintained on that limited portion of the three States in which it is known to occur. The quarantine regulates the movement of products likely to carry the pest and authorizes their movement from the regulated area only when they comply with safeguards necessary to prevent further distribution of the pink bollworm. In addition to governing the movement of products likely to carry the insect, Federal and State quarantine regulations provide for carrying on certain measures, such as the sterilization of cottonseed by heat, which reduce the abundance of the pest within the infested area. Another Federal quarantine regulates the entry into the United States of cotton and cotton products from countries in which the pink bollworm is known to occur.

The small whitish or pinkish caterpillars (fig. 10) eat out the seeds of the cotton plant, and not only diminish the yield of seed but also cause the seeds to be light in weight and low in vitality, with the oil content lessened and of low value. In addition, the lint is reduced in quantity and quality, being short, matted together, and more or less discolored. In cases of severe infestation both squares and small bolls are shed, as under boll weevil infestation. The pink bollworm, however, has a decided preference for bolls.

---

[5] U. S. Dept. Agr. Leaflet 53, Cotton-Louse Control.

The adults are small brown moths (fig. 11) somewhat resembling the common clothes moths, active at night, quiet in the daytime, and easily overlooked even when abundant.

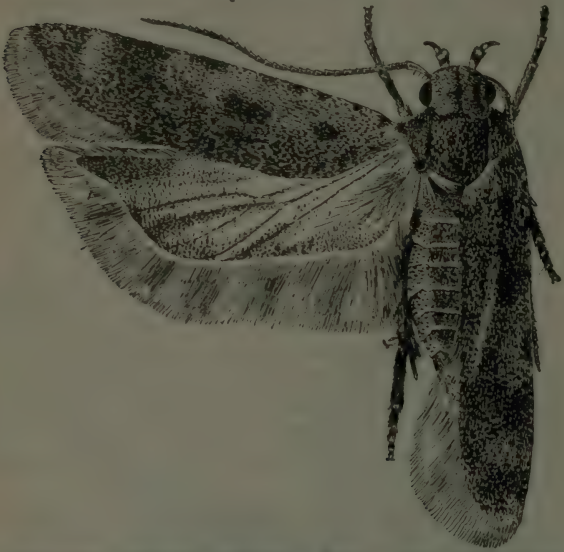


FIGURE 11.—The pink bollworm: Adult. Six times natural size. (Busck)

Several kinds of caterpillars superficially resemble the pink bollworm and may be mistaken for it. Positive identification of the insect in any of its stages can be made only by specialists and with the aid of a microscope. Agents of the Federal department as well as officers in the various States are continuously on the lookout for this pest. Should any reader of this bulletin find specimens which he thinks may be the pink bollworm, he should immediately kill them. A few specimens should be placed in formalin or some other preservative and forwarded to the Bureau of Entomology for identification. Under no conditions should live material be forwarded, distributed, or moved anywhere. To do so is a punishable offense under Federal and State laws.

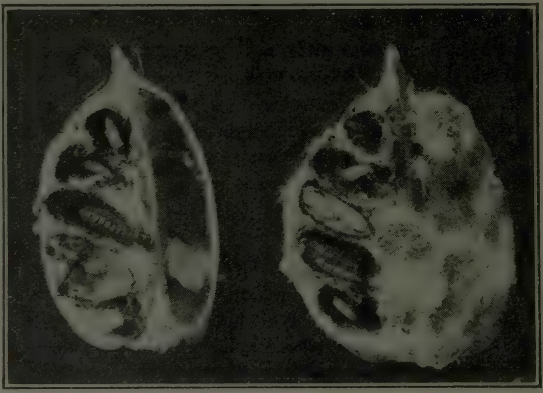


FIGURE 12.—Immature cotton boll showing characteristic damage by pink bollworm

An infestation may escape notice for a long time, as immature bolls containing the worms show no conspicuous external signs of their presence. (Fig. 12.) The larva when full grown cuts a round hole through the boll—a hole smaller than that made by the common bollworm. A clean-cut hole indicates that the larva has emerged to go to the ground to pupate (fig. 13); a hole with frass or castings in it is a sign that the larva is still within the boll, where it often pupates. Occasionally a larva goes from one lock into the next one, and in so doing makes a characteristic round hole through the partition between the two locks. Often a larva hollows out two adjacent seeds and webs them together, forming the characteristic double seeds. (Fig. 14.) These double seeds pass through the gin, and their occurrence at a gin affords an easy means of detecting an infested locality.

The caterpillar, on hatching, bores into a square or boll. Infested squares usually form flowers, but these fail to open out fully on account of being webbed by the larva within. Since the insect requires only from one to two months in the growing season to develop from egg to adult, there may be three or more successive generations in one season, in the case of short-cycle larvae. Late in the season, however, other caterpillars, known as long-cycle larvae, may enter a resting condition, usually inside seeds, but sometimes in trash on the ground or on the taproots of cotton plants; this condition may last as long as 31 months (an extreme case) before pupation occurs. This longevity serves to carry the insect over unfavorable periods and also enables it to be transported alive to any part of the world.

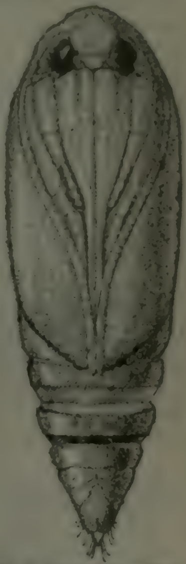


FIGURE 13.—The pink bollworm: Pupa. Seven times natural size. (Busck)

In districts where the pink bollworm is known to occur, farmers should carefully abide by all regulatory orders issued by State or Federal Government. Such orders, particularly those

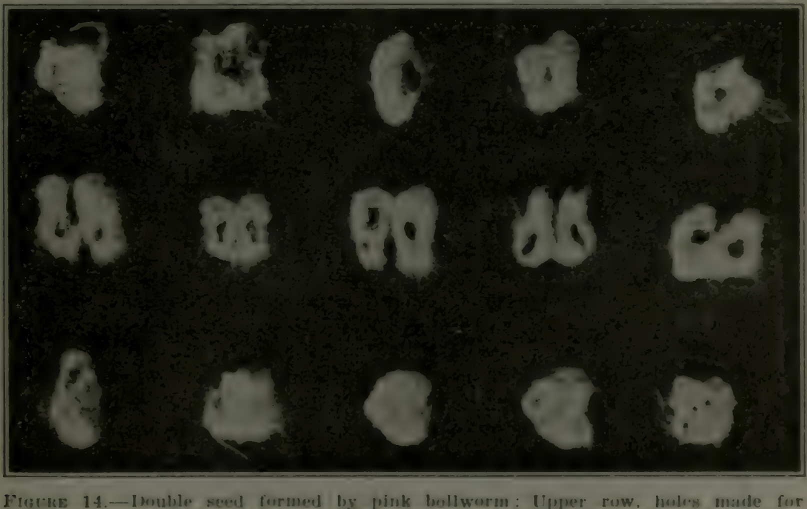


FIGURE 14.—Double seed formed by pink bollworm: Upper row, holes made for emergence of moth; middle row, seeds broken apart to show cavities; lower row, double seeds intact

which require the sterilization of seed, fumigation of lint, and disposal of gin trash, are promulgated to help reduce the numbers of this pest.

Farmers, in addition to carrying out these requirements, should try to secure as early a crop as possible. As soon as practical after the cotton is picked the old plants and all other crop remnants should be destroyed. Drying and burning is effective. The burial of old bolls, cotton stalks, and trash reduces the numbers of hibernating larvae. Early winter burial of crop remnants followed immediately by irrigation is very effective in destroying larvae within the soil and under certain soil conditions gives almost 100 per cent control.

THE COTTON LEAF PERFORATOR

The cotton leaf perforator (*Bucculatrix thurberiella* Busck), a leaf-mining insect, was discovered in Arizona on wild cotton (Thurberia). It occurs also in Texas and Mexico and has caused enormous losses to cultivated cotton in the Imperial Valley of California. Very high temperatures are favorable for its multiplication, but it can exist at altitudes of 4,000 or 5,000 feet, where the winters are comparatively cold, and, unless high humidity is an adverse influence, would apparently be able to survive under any climatic conditions that occur in the Cotton Belt.

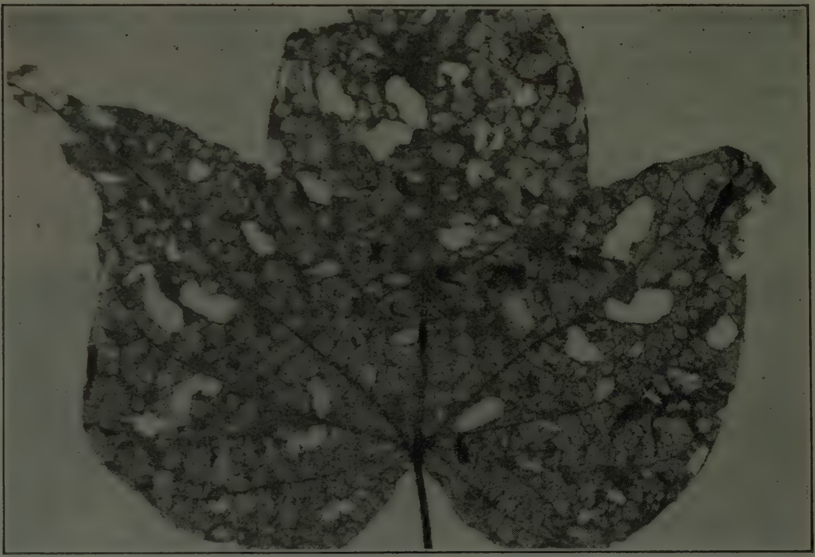


FIGURE 15.—Cotton leaf badly damaged by the cotton leaf perforator

Damage from the perforator is greatest on soils having low fertility, in poorly cultivated fields, and on volunteer cotton. The caterpillars destroy the foliage, causing the squares or small bolls to fall off, or the small bolls may open prematurely and produce a short-staple lint of little value.

At first the larva makes a serpentine tunnel, gradually widened as the larva grows. Older larvae make perforations in the leaves which often give the foliage a lacelike appearance. (Fig. 15.)

Characteristic of the greenish larvae are the black eye spots, prominent white tubercles, and particularly a pair of large, roundish black spots above, at the border of each body segment. The pale yellow egg, barely visible to the naked eye, is long, with longitudinal ridges, and stands on end on a leaf. The white cocoon, spun on a leaf or elsewhere, is also longitudinally ribbed. The moths are small, white, and very active at night.

The period required for development from egg to adult ranges from about 15 to 70 days, according to the season. It averages 18 days, and there is a possibility of 9 or 10 generations annually in the Imperial Valley.

Preliminary tests have indicated that the perforator can be controlled profitably by dusting with powdered lead arsenate, used at the rate of 5 to 7 pounds per acre, and applied early in the morning when the air is calm and dew is on the plants. From one to three applications are necessary, according to the severity of the infestation.

THE RED SPIDER

The mite known as the red spider (*Tetranychus telarius* L.) has been, sporadically, one of the most destructive of cotton pests, especially in the Southeast. The first sign of mite attack is a blood-red spot on the upper surface of a leaf; then infested leaves turn red or rusty, dry up, and fall; bolls are shed and plants may die. This injury, often called "rust" by cotton planters, begins about the middle of June and may continue for about three months.

The red spiders (fig. 16), barely visible to the naked eye, may be greenish or yellowish but are commonly red (female) or reddish yellow (male). These mites work on the undersides of leaves, laying their eggs there, spinning delicate webs, and sucking sap from the leaves, which become thickly dotted with their minute punctures. As many as 17 generations a year have been observed.

The red spider has been found on almost 200 species of plants, including garden and field crops, ornamentals, and weeds. In the South it survives the winter on such leaves as may remain green, as those of blackberry and various weeds. Pokeweed and the English violet have been sources of infestation on cotton. In early summer the mite may go from weeds into near-by cotton. When the cotton is no longer suitable as food the mites go back to the weeds. They have been seen crawling on the ground and are known to be carried by water and by wind.

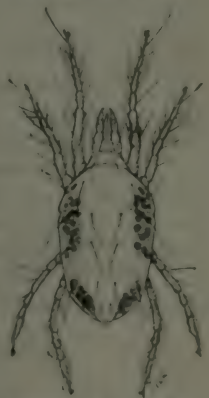


FIGURE 16.—The female red spider, 60 times natural size. (McGregor and McDonough)

Hot, dry conditions are most favorable for rapid multiplication of the red spider; heavy rains often check the pest effectively.

As a most important preventive, all weeds and underbrush near a cotton field should be cut and burned in winter or early spring. Growing weeds may be killed by spraying them with 1 pound of sodium arsenite in 20 gallons of water.

As red-spider injury to cotton is usually confined to young plants, early planting is advantageous. In an emergency an infestation that has not advanced far can be checked by pulling up and destroying such plants as show damage. Plowing affected areas to bury the mites and save the rest of the field is advisable in cases of severe local infestation.

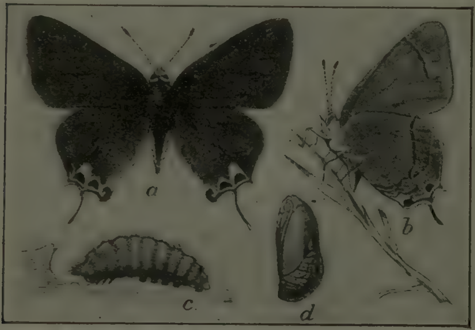


FIGURE 17.—Cotton square borer: *a*, Adult butterfly, top view; *b*, same from side, with wings closed; *c*, larva or borer, from side; *d*, pupa. Enlarged to 1⅛ times natural size. (Howard)

It is possible to kill the red spider by thoroughly spraying the undersides of the leaves with certain contact insecticides, such as potassium sulphide (1 ounce to 2 gallons of water), kerosene emulsion, or flour paste solution.[6]

Dusting cotton with finely ground sulphur (sulphur flour) at the rate of 10 pounds per acre is recommended to control the red spider. As a combined boll-weevil and red-spider application, 8 pounds of sulphur may be mixed with 4 pounds of calcium arsenate for each acre.

MISCELLANEOUS INSECT PESTS OF COTTON

Most of the insects next to be considered are common in cotton fields and collectively do more or less damage. Occasional outbreaks of one or another, under special conditions, may call for special treatment; but ordinarily most of these miscellaneous insects are held in check incidentally by the measures used against the major insect pests. For example, the measures employed in control of the boll weevil operate also to suppress immense numbers of other insects on cotton.

THE COTTON SQUARE BORER

The cotton square borer (*Strymon melinus* Hbn.) is frequently found in cotton fields, where it attracts attention by boring into squares, but ordinarily it does not become of much economic importance, usually being held in check by its natural enemies. It is not limited to cotton but feeds also on okra, cowpea, bean, corn, goat-weed, and many other plants.

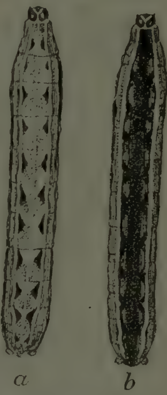


FIGURE 18.—Yellow-striped army worm: *a*, Light form of larva; *b*, dark form of larva. Enlarged to 1⅙ natural size. (Chittenden)

Like the bollworm, the square borer eats out the contents of squares, which then flare and are shed. It also bores in the growing tips of the cotton plant. Unlike the bollworm, however, this borer is a little, oval, velvety-green caterpillar (fig. 17), which at length becomes a small bluish-gray butterfly.

This borer can be controlled when necessary by dusting the cotton with calcium arsenate at the rate of from 5 to 7 pounds to the acre. The regular dustings for the boll weevil incidentally check this and several other cotton insects.

---

[6] Farmers' Bulletin 831, The Red Spider on Cotton and How to Control It.

THE YELLOW-STRIPED ARMY WORM

The yellow-striped army worm, or cotton-boll cutworm (*Prodenia ornithogalli* Guen.) feeds on various kinds of weeds, field crops, truck crops, and ornamental plants. It is common on the foliage of young cotton plants, and may dwarf or deform the growth of the plants, retard fruiting, or even kill them. It bores into bolls as does the bollworm, but its worst injury is to young cotton, which it attacks after the manner of other cutworms (p. 24), causing loss of stand.

The caterpillar (fig. 18) is olive green or greenish brown in color, with rows of triangular black spots on the back. The adult or moth is shown in Figure 19.

Frequent cultivations destroy the pupae in the soil. Dusting with calcium arsenate for the boll weevil also kills these and other caterpillars. On young cotton the methods of control used for other cutworms (p. 24) are effective.

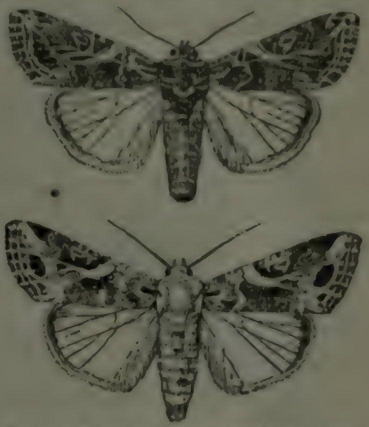


FIGURE 19.—Yellow-striped army worm: Above, dark form of moth, male; below, pale form of moth, female. Enlarged to 1¼ times natural size. (Chittenden)

THE COTTON STAINER

In the United States a West Indian species, the cotton stainer, or red bug (*Dysdercus suturellus* H.-Sch.) has been injurious only in Florida, where it was at one time the most important cotton insect. It has been reported also from Georgia, South Carolina, and Alabama.

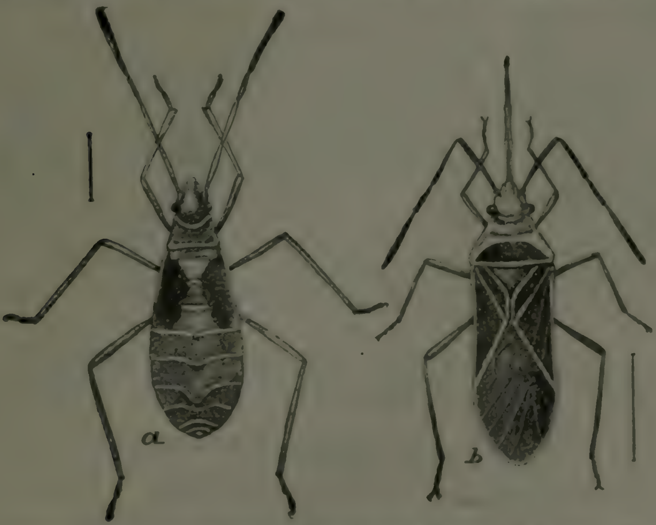


FIGURE 20. Cotton stainer: *a*, Fourth-stage nymph; *b*, adult. Enlarged to 4 times natural size. (Insect Life)

These conspicuous red and brown or red and black bugs (fig. 20), occurring in colonies, puncture bolls and seeds, often destroying small bolls and ruining parts of large ones. The sap from young bolls or from seeds sucked by the insects, with excremental fluid as well, stains the lint brownish yellow or reddish and greatly lowers its value.

These bugs feed also on a few wild plants, such as nightshade and particularly Spanish cocklebur. Weeds upon which the bug breeds should be destroyed.

The fact that the cotton stainers occur in colonies, limited for a long time to one or a few plants, permits their destruction by hand. They can be jarred into a bucket of water having a surface layer of kerosene. In fall and early spring small piles of cottonseed attract great numbers of these bugs, which may then be killed with hot water or kerosene.

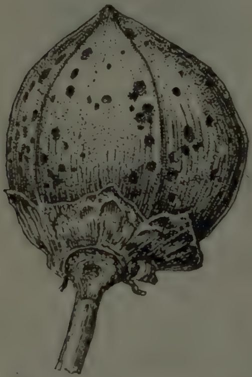


FIGURE 21.—Cotton boll showing punctures of cotton plant bug. (Sanderson)

THE COTTON PLANT BUG

The cotton plant bug (*Adelphocoris rapidus* Say) feeds on many kinds of cultivated plants and on weeds. On cotton it punctures not only leaves and stems but also squares and young bolls, which fall off as a result. On larger bolls (fig. 21) each puncture becomes surrounded with black, giving the appearance of pink boll rot or anthracnose. The greatest damage by the bug on cotton is due to its puncturing very small squares, which then become blasted and are shed. In causing blasted squares and consequent lack of blooms, this bug produces injury similar to that of the cotton flea hopper.

The adult bug (fig. 22) is dark brown above, edged on each side with yellow. The nymphs are pale green, marked with red.

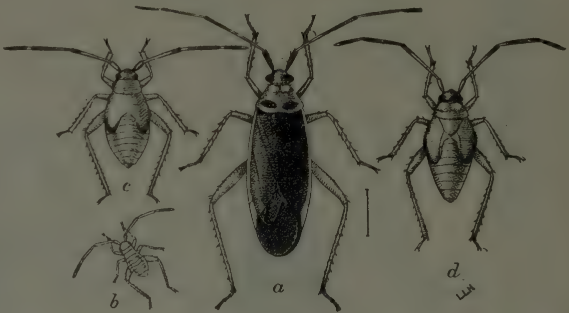


FIGURE 22.—Cotton plant bug: *a*, Mature bug; *b*, young nymph; *c*, fourth-stage nymph; *d*, fifth-stage nymph. Enlarged to 4 times natural size. (Sanderson)

Dusting the cotton plants with sulphur, as for the flea hopper (p. 9), is recommended as a means of control.

THE TARNISHED PLANT BUG

A widely distributed and omnivorous pest of plants is the tarnished plant bug (*Lygus pratensis* L.), which not only feeds on a great many kinds of weeds but also attacks fruit trees, small fruits, truck crops, flowering plants, and some grains.

The adult (fig. 23) is yellowish brown to blackish in general color, variegated with shades of yellow, red, and black. The nymphs or young bugs are green, and the older nymphs have four black spots on the thorax.

The bugs hibernate as adults under dead leaves, rubbish, loose bark, or other shelter, from which they emerge early in spring. Eggs are laid on a great variety of plants, and may be inserted into stems or leaves, or laid in flower heads, especially those of composites, among which certain species of fleabane (*Erigeron* sp.) are preferred. Weeds, in fact, are the natural breeding plants of this insect.

In 1926 this species was very abundant in the Southern States, where it made destructive and unprecedented attacks on cotton. It was associated with the cotton flea hopper in blasting young squares, thereby preventing the formation of flowers, and causing an abnormal growth and development of the plant. The bugs attacked the cotton in the day time. Millions of them spent the nights in the dense weeds around the borders of the cotton fields. At sunrise they left the weeds and flew back to the cotton.

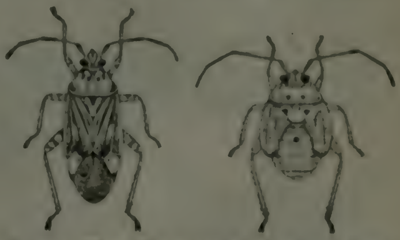


FIGURE 23.—The tarnished plant bug: Adult bug at left; last stage of nymph at right. Nearly 4 times natural size. (Orton and Chittenden)

Dusting cotton plants with sulphur, as for the flea hopper (p. 9), is recommended. Weeds and other trash should be burned in cold weather to destroy hibernating bugs. Cutting and burning the weeds during the growing season will kill many of the wingless nymphs.

THE COTTON DAUBER

The cotton dauber (*Lygus elisus* Van D.), which closely resembles the tarnished plant bug, has been a pest in Arizona and New Mexico and one of major importance in California, particularly in the Imperial Valley.[7] There it occurs on alfalfa during most of the growing season. When the alfalfa dries out or is cut in early summer, however, the insect migrates into near-by cotton. On alfalfa the pest distributes its damage, but on cotton it concentrates entirely on buds, blooms, and young bolls, which are soon shed in consequence. As the bug sucks sap from the plant it deposits drops or daubs of yellow excrement—hence its name.

In combating this bug on either alfalfa or cotton, a single application of sulphur dust, at the rate of 10 pounds per acre, as for the flea hopper (p. 9) has been found to be effective.

THE GARDEN WEBWORM

The garden webworm (*Loxostege similalis* Guen.), common throughout North America, attacks a great variety of garden and field crops, and has at times ruined fields of small corn and cotton, necessitating replanting.

---

[7] U. S. Dept. Agr. Tech. Bul. 4, Lygus elisus: A Pest of the Cotton Regions in Arizona and California. 1927.

The caterpillar feeds primarily on weeds, preferring pigweed (Amaranthus), known also as "careless weed," and is often called the "careless worm." The moths emerge from the soil in spring and may lay eggs on cultivated plants if its preferred weeds are not at hand. Larvae may feed on alfalfa in early spring until the crop is cut and then move into adjoining corn or cotton.

The larvae (fig. 24), which are yellowish or greenish yellow with conspicuous black dots make webs on the foliage of plants and pupate in the soil. The moths (fig. 25) vary in color, being commonly grayish but often reddish yellow.

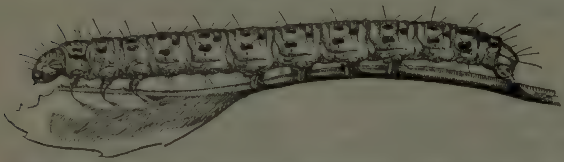


FIGURE 24.—The garden webworm: Caterpillar or "worm." Three times natural size. (Kelly and Wilson)

The destruction of weeds is advised as a preventive. Thorough cultivation of land in fall or winter is recommended. Dusting with calcium arsenate is effective as a check.

THE SALT-MARSH CATERPILLAR

The salt-marsh caterpillar (*Estigmene acraea* Dru.), common everywhere on grasses, weeds, garden crops, and so forth, has on rare occasions been sufficiently abundant to strip entire fields of cotton. It may dwarf or deform seedling plants, retard fruiting, or kill the plants.

The caterpillar, one of the "woolly bears" (fig. 26), is clothed with long, brown or black hairs arising in clusters from yellow tubercules.

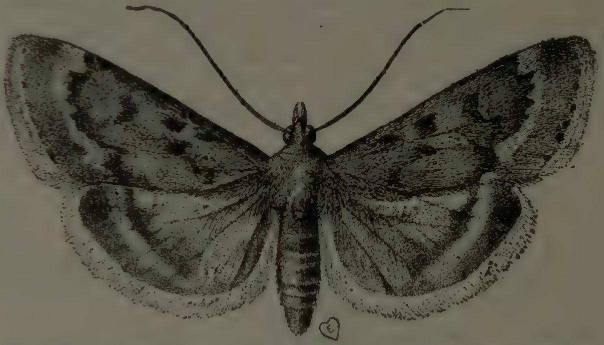


FIGURE 25.—Parent of the garden webworm. Four times natural size. (Kelly and Wilson)

Control of weeds around cotton fields is a logical method of checking this and many other cotton insects. Direct methods of control by means of poisons are the same as for the cotton leaf worm (p. 7).

THE FALL ARMY WORM

The fall army worm, or grass worm (*Laphygma frugiperda* S. and A.), a native of subtropical America, is common every year in the United States, and at times, under favorable conditions, becomes abundant and destructive. In this country the insect is able to survive the winter only in southern Florida and southern Texas, but as the season advances successive broods may spread over the United States east of the Rocky Mountains and even into Canada.

The worms normally feed on grasses of many kinds, especially crab grass and Bermuda grass, and if they are not full grown after consuming these they travel in search of more food. They are very destructive to cultivated grasses, especially corn and sorghum, and to alfalfa and cowpeas, but will attack almost any field or truck crop. Cotton is not a favorite food plant of the fall army worm, but a poorly cultivated cotton field, overrun with grass, may be injured. On cotton the worm characteristically tops the plants, cutting off branches and squares. Severe damage to cotton, to the extent of defoliation, occurs rarely and only under exceptional conditions, as, for example, when other food is scarce, as after an overflow.

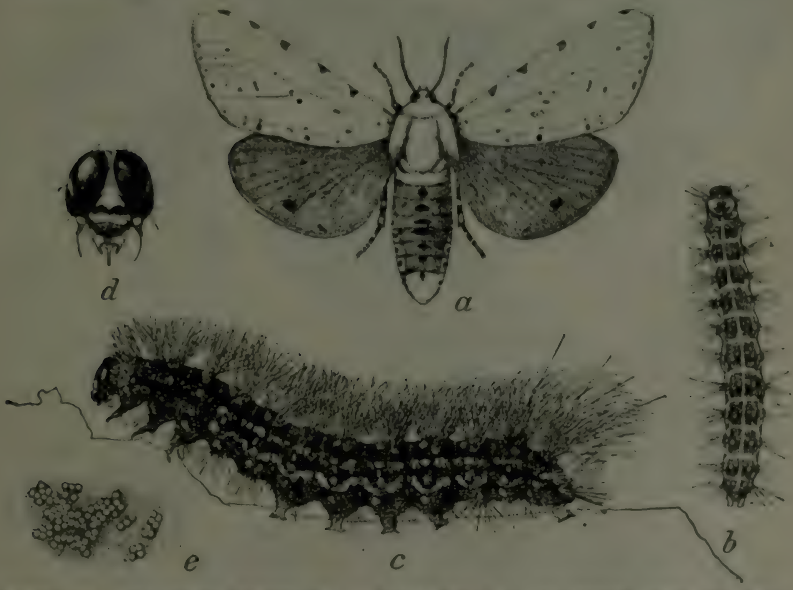


FIGURE 26.—Salt-marsh caterpillar: *a*, Male moth; *b*, half-grown larva or caterpillar; *c*, full-grown larva, side view; *d*, head of larva, front view; *e*, egg mass. All enlarged to 1¼ times natural size except *d*, which is more enlarged. (Chittenden)

The worms (fig. 27) attain a length of 1½ inches, and vary in general coloration from pale green to almost black. Usually the front of the head has a white mark like an inverted Y which is characteristic of the species. The adult is a dull-grayish moth having satiny-white hind wings.

Proper cultivation usually will protect a cotton field from this worm. Shallow cultivation after the worms have entered the soil to pupate destroys many pupae and exposes others to the killing heat of the sun. Fall plowing is a useful preventive.

While young worms are still feeding in grasslands they can be killed by dusting with calcium arsenate or other arsenicals. Spraying with 1 pound of powdered lead arsenate to 50 gallons of water is also a means of control. Poisoned bran mash, as used for cutworms (p. 24), is an effective bait for this caterpillar also.

Fields which have been sprayed or dusted are dangerous as pastures until after a heavy rain has fallen or for at least three weeks after the insecticide has been applied.

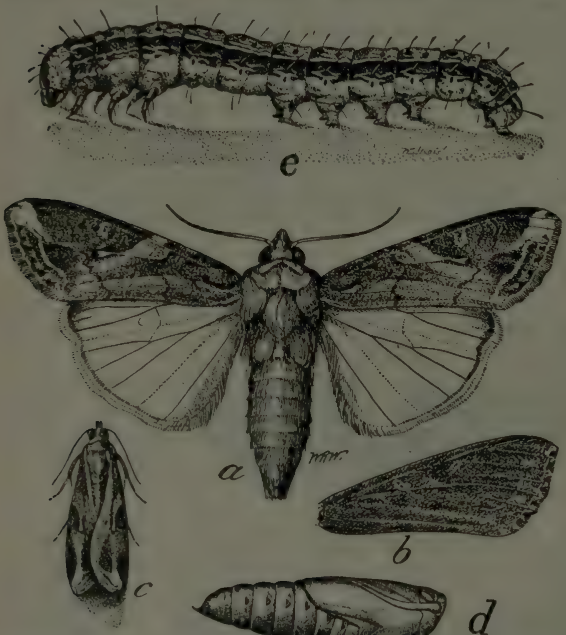


Figure 27.—Fall army worm or grass worm: *a*, Adult male moth; *b*, right front wing of female moth; *c*, moth in resting position; *d*, pupa; *e*, full-grown larva. *a*, *b*, *d*, *e*, About twice natural size; *c*, slightly enlarged. (Walton and Luginbill)

A field can be protected from an advancing army of these worms by making a barrier in the form of either a deep furrow or a line of coal tar.[8]

THE COWPEA CURCULIO

A bronze-black weevil, the cowpea curculio (fig. 28) (*Chalcodermus aeneus* Boh.), has often been locally destructive to cotton in the Gulf States, Georgia, South Carolina, and North Carolina. Its damage is done in the early spring to small cotton, which the weevils may eat down to the ground, but this injury has occurred only in fields that were in cowpeas during the preceding year. The beetles hibernate in the soil of the cowpea field and after emerging attack young cotton in the absence of other food.

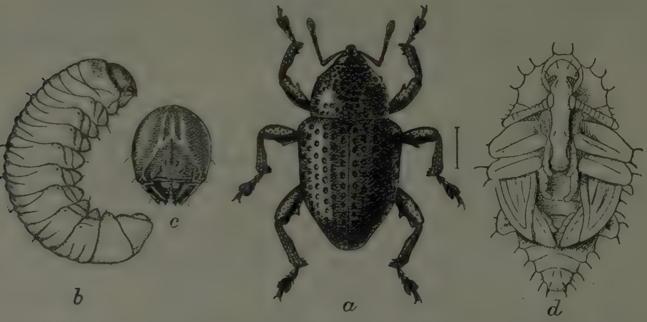


Figure 28.—Cowpea curculio: *a*, Adult weevil; *b*, larva, side view; *c*, head of same, front view; *d*, pupa, viewed from below. Five times natural size, except *c*, which is enlarged about 12 times. (Chittenden)

---

[8] Farmers' Bulletin 752, The Fall Army Worm, or "Grass Worm," and Its Control.

It has been suggested that cotton following cowpeas be planted thickly and the chopping delayed as long as possible in order to secure a uniform stand.

MAY BEETLES

A few species of May beetles (*Phyllophaga cribrosa* Lec., *P. lanceolata* Say, *P. farcta* Lec.), two of which are shown in Figures 29 and 30, have occasionally injured seedling cotton plants considerably, especially in Texas and Oklahoma. These species winter in the soil as white grubs or as beetles and their damage consists of the destruction of young plants by the beetles. These feed by night or in the darker part of the day on various cultivated plants or on weeds, and hide in the ground during most of the daytime. The damage is greatest in fields of cotton following grass or weeds. Weeds and cotton fields may be dusted with calcium arsenate if necessary at the rate of from 4 to 6 pounds per acre. Winter plowing has been recommended to kill the grubs and beetles in the soil.

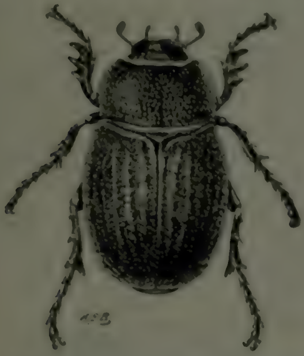


FIGURE 29.—May beetle, *Phyllophaga cribrosa*. Enlarged to 1½ times natural size. (Sanderson)

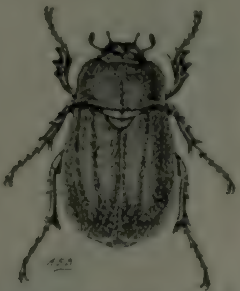


FIGURE 30.—May beetle, *Phyllophaga lanceolata*. Enlarged to 1½ times natural size. (Sanderson)

GRASSHOPPERS

Grasshoppers have in some years been very destructive to cotton in some of the Southern States, especially Texas. Two species have been especially injurious. The differential grasshopper (*Melanoplus differentialis* Thos.) has destroyed hundreds of acres of cotton at a time in Mississippi and Texas. Its eggs, laid in uncultivated ground, hatch in early spring, and the grasshoppers feed at first on grasses and weeds, but if this food fails they may attack young corn or cotton. The lubber grasshopper (*Brachystola magna* Gir.) (fig. 31), a clumsy, short-winged species, often injurious in Texas, unfortunately attacks cotton during the entire season.

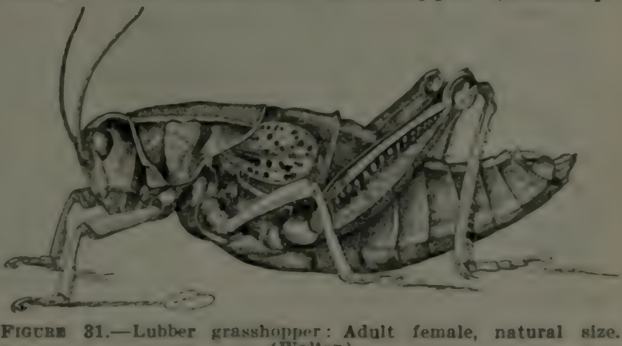


FIGURE 31.—Lubber grasshopper: Adult female, natural size. (Walton)

It has been found possible to check these grasshoppers by spraying weeds and grasses on uncultivated lands with kerosene or crude oil. Dusting with calcium arsenate or other arsenical is recommended. Poisoned-bran mash, as used for cutworms, has proved an effective means of control, but when it is used cooperation among planters is essential to the best results.

CUTWORMS

Young cotton plants are often destroyed by several species of cutworms, which cut the stem in two or feed on the leaves.

The cutworms (fig. 32), of which there are many kinds, are stout, cylindrical, almost naked caterpillars, gray to brown or blackish in color, sometimes spotted or striped, commonly found in the soil and usually curled up when resting. During the day they are usually hidden in the soil or under clods or other shelter, but by night or on dull days they feed by cutting the stems of onion, cabbage, potato, corn, and other small plants. Often a cutworm burrows into the soil close by a plant that it has cut, and so may easily be found.

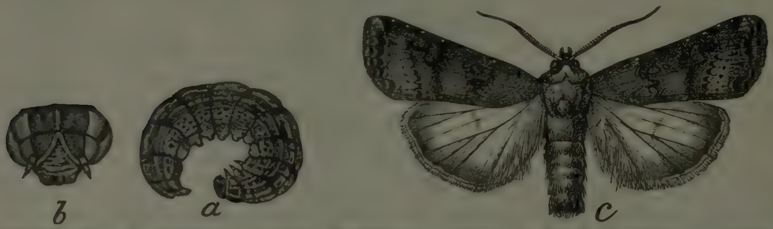


FIGURE 32.—A cutworm. *Agrotis ypsilon: a,* Larva; *b,* head of same; *c,* adult moth. Natural size, except *b.* (Riley and Howard)

Cutworm damage to cotton in spring has frequently been so severe as to necessitate replanting. A heavy sowing of seed to secure a good stand of cotton is an insurance against serious damage.

The recommended remedy for cutworms, and various other chewing insects as well, is poisoned-bran mash, which is prepared as follows:

Wheat bran	25 pounds
Paris green or white arsenic (Or else calcium arsenate or lead arsenate, 2 pounds)	1 pound
Low-grade molasses or blackstrap	2 quarts
Water	3 to 5 gallons

Mix the bran and poison thoroughly. Add the molasses and mix again, then add water. The resulting mixture should be crumbly, so that it can be broadcast. At least 10 pounds per acre should be scattered over a field, preferably in the evening, as the mash is more effective when moist. Keep poultry and livestock out of poisoned fields.[9]

SHARPSHOOTERS

Several kinds of sharpshooters (*Homalodisca triquetra* Fab., *Oncometopia undata* Fab., *O. lateralis* Fab., and *Aulacizes irrorata*

---

[9] Farmers' Bulletin 739, Cutworms and Their Control in Corn and Other Cereal Crops.

Fab.) (fig. 33) are familiar insects in cotton fields in summer and fall, and when approached attract attention by their habit of dodging around the stem of a plant.

These insects should be mentioned because they are so often blamed for damage to the cotton plant. They are not known to attack squares, blooms, or bolls, however, although they habitually puncture the stem and from it they extract, in the aggregate, immense quantities of sap. This constitutes a drain on the plant which theoretically would tend to retard growth, but as a matter of fact the plant seems able to withstand this loss of sap, and injury from these insects is probably slight.

The sharpshooters, generally speaking, hibernate as adults, feed in spring on elm, willow, cottonwood, hackberry, etc., and later on other plants, such as sunflower, sorghum, corn, and cotton, and are always common on weeds. The eggs are sometimes laid on cotton, but usually on other plants.

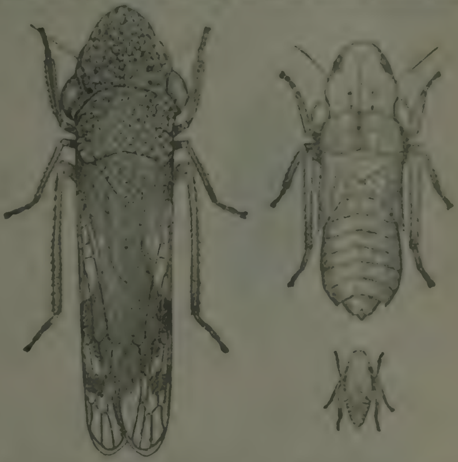


FIGURE 33.—A sharpshooter, *Homalodisca triquetra:* Adult at left; last-stage nymph, or young, at right above; young nymph at right below. Enlarged to 4½ times natural size. (Sanderson)

THE CORN ROOT APHID

The bluish-green plant louse called the corn root aphid (*Anuraphis maidiradicis* Forbes) is a pest of corn in the North and has at times been destructive to young cotton in the South, especially in North Carolina and South Carolina.

Young, tender plants, as soon as they are out of the ground, may turn red and die when these lice are sucking sap from the roots. When the roots get hard and woody the winged aphids leave them, and the wingless aphids are transferred by their attendant ant companions to succulent roots of other plants. The most serious injury to cotton has occurred where it was planted after corn.

The simplest method of control is a system of rotation in which cotton does not directly follow corn or cotton. A 3-year rotation that has proved successful is (1) oats and cowpeas, (2) cotton, (3) corn. The borders of fields should be kept free from weeds, many of which harbor the aphids. A shallow cultivation of infested fields breaks up the nests of the ants that care for these aphids, and kills many of the aphids by burying them.

WIREWORMS

At least two species of wireworms (*Monocrepidius vespertinus* Fab. and *Horistonotus uhleri* Horn) have done considerable damage to young cotton, particularly in South Carolina. The worms are especially troublesome because of the fact that they may live in the soil for two and possibly three years before transforming into beetles. These wireworms bore into seeds or eat the roots of young plants, often killing the plants before they have appeared above ground. Affected plants, if not killed, are dwarfed and sickly. Commonly the injury occurs in spots in fields; often there are bare spots where all the young cotton has been killed.

The adults are the well known click beetles (fig. 34), so called because when one of them happens to be on its back it bends upward and then, by suddenly straightening out, snaps itself into the air with a click. This process is repeated, if necessary, until the beetle lands on its feet. These beetles feed more or less on foliage of cotton and are said to injure young squares also.

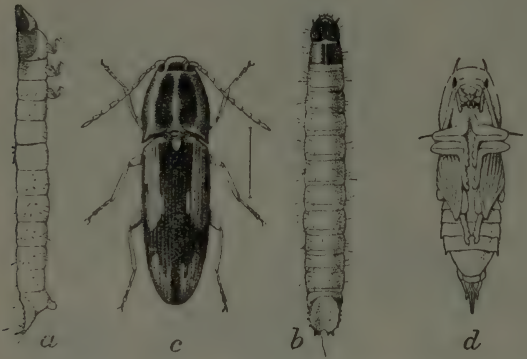


FIGURE 34.—A cotton wireworm, *Monocrepidius vespertinus*: *a*, Larva, or wireworm, side view; *b*, same, top view; *c*, adult, or beetle; *d*, pupa. Three and one-half times natural size. (Chittenden)

No entirely satisfactory method for the control of these wireworms has yet been developed. However, since the sandy-land wireworm (*Horistonotus uhleri* Horn) does not lay its eggs on untilled soil, a system of handling the ground and the crops preceding cotton so that the soil will not be disturbed from the middle of June to the middle of August is very important. This may be accomplished by omitting from the rotation such crops as require summer cultivation.

GENERAL CONSIDERATIONS

To get a good crop of cotton in spite of the insect pests, the greatest possible amount of cotton must be matured in the shortest possible time. The rate of fruiting must outstrip the rate of insect multiplication. This involves the agricultural practices given in this bulletin. Of these, the importance of seeding heavily must be emphasized. An excess of seedlings may not only give a good start toward a good stand of plants, but may also insure a good stand even when insect enemies of young plants (as cutworms, webworms and other caterpillars, May beetles, grasshoppers, root aphids, and wireworms) are present.

As has been stated, comparatively few cotton insects are habitually of sufficient importance to require direct control measures. Many others are less important but nevertheless of importance in the aggregate, and some of them may, under special conditions, demand special methods of control. As a rule, however, the methods used to control the major insect enemies of the cotton plant will control or restrain many of the minor ones at the same time.

The insects that the cotton planter has to deal with fall into two groups according to the nature of their mouth parts and consequent habit of feeding—the chewing and the sucking insects. Correspondingly, there are two classes of insecticides, broadly speaking—stomach poisons and contact insecticides. Chewing insects (weevils, beetles, caterpillars, grasshoppers) can be killed by means of a poison such as calcium arsenate applied to their food. Calcium arsenate is at present the poison best adapted to the needs of the cotton grower. A sucking insect, on the contrary, which pierces a plant with its beak and sucks the sap (flea hopper, leaf bug, other plant bugs, and plant lice) can not be controlled with a stomach poison, but succumbs to contact insecticides, of which two are commonly used in cotton fields, nicotine dust and finely ground sulphur (sulphur flour).

In cases of joint infestation, as when, for example, both boll weevils and plant lice are attacking plants at the same time, a combined application (in this instance nicotine dust with calcium arsenate as the carrier) frequently can be made.

SUMMARY OF CONTROL MEASURES

While special methods are necessary to control outbreaks of several of the cotton insects, the measures used to control the boll weevil operate also against most of the other insect pests of cotton.

It is most important to plant a variety of cotton that is adapted to weevil conditions; in other words, that will produce the greatest possible quantity of fruit in the shortest possible time.

Sow the seed heavily, to insure a good stand of young plants to begin with.

Practice reasonably early planting and frequent careful cultivation.

Use fertilizers where required.

Pick the cotton as soon as possible and then destroy the plants without delay, by grazing, burning, or plowing them under. When conditions permit, cotton stalks should be turned under instead of being burned. The stalks should be destroyed at least two weeks before the first killing frost is likely to come, if much benefit is to be had from that measure; and one month before, in order to get the maximum benefit. This method is obviously most suitable for the more southerly parts of the Cotton Belt, where the crop matures early and the first killing frost comes late.

Burn weeds and other trash in winter. Burn especially the weeds on ditch banks, at the edges of timber adjoining cotton fields, and within the cotton field.

Keep down weed growth near cotton fields in spring.

Rotate crops, following a system of rotation that is best adapted to prevent insect infestation and maintain soil fertility in your particular locality.

Watch the progress of boll weevil infestation and control the weevil by dusting with calcium arsenate at the proper times and in the correct manner.

Always have a supply of calcium arsenate on hand for emergency use as well as for regular boll weevil dusting.

If you desire information concerning an insect that is strange to you, send specimens of the insect, properly preserved, to the Bureau of Entomology of the United States Department of Agriculture, Washington, D. C.

Additional printed matter on the more important kinds of cotton insects may be obtained from the Division of Publications of the United States Department of Agriculture, Washington, D. C.

It will pay the planter to learn to distinguish the injurious cotton insects, to recognize the work of each one of them on the plant, and to inspect his fields frequently, that he may detect insect damage when it begins and may be able to remedy it promptly.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	Arthur M. Hyde.
Assistant Secretary	R. W. Dunlap.
Director of Scientific Work	A. F. Woods.
Director of Regulatory Work	Walter G. Campbell.
Director of Extension Work	C. W. Warburton.
Director of Personnel and Business Administration.	W. W. Stockberger.
Director of Information	M. S. Eisenhower.
Solicitor	E. L. Marshall.
Weather Bureau	Charles F. Marvin, *Chief.*
Bureau of Animal Industry	John R. Mohler, *Chief.*
Bureau of Dairy Industry	O. E. Reed, *Chief.*
Bureau of Plant Industry	William A. Taylor, *Chief.*
Forest Service	R. Y. Stuart, *Chief.*
Bureau of Chemistry and Soils	H. G. Knight, *Chief.*
Bureau of Entomology	C. L. Marlatt, *Chief.*
Bureau of Biological Survey	Paul G. Redington, *Chief.*
Bureau of Public Roads	Thomas H. MacDonald, *Chief.*
Bureau of Agricultural Engineering	S. H. McCrory, *Chief.*
Bureau of Agricultural Economics	Nils A. Olsen, *Chief.*
Bureau of Home Economics	Louise Stanley, *Chief.*
Plant Quarantine and Control Administration	Lee A. Strong, *Chief.*
Grain Futures Administration	J. W. T. Duvel, *Chief.*
Food and Drug Administration	Walter G. Campbell, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	James T. Jardine, *Chief.*
Office of Cooperative Extension Work	C. B. Smith, *Chief.*
Library	Claribel R. Barnett, *Librarian.*

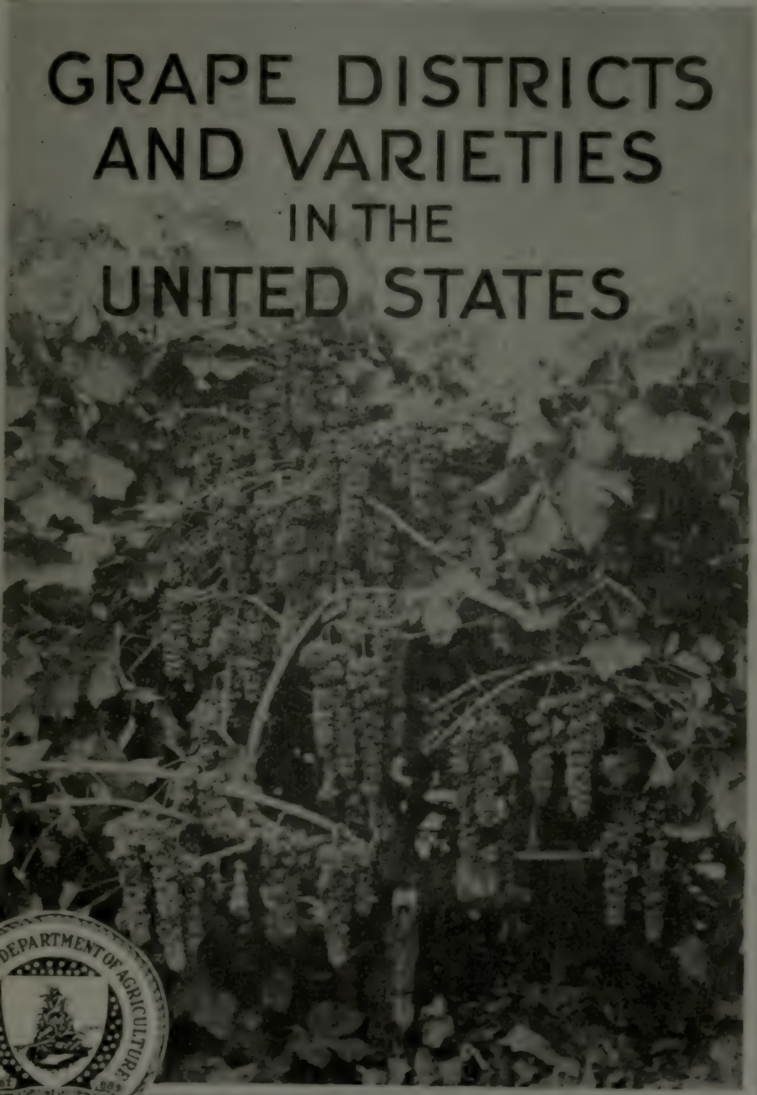
29

U. S. GOVERNMENT PRINTING OFFICE 1932

For sale by the Superintendent of Documents, Washington, D. C.

U. S. DEPARTMENT OF
AGRICULTURE
FARMERS' BULLETIN No. 1689

GRAPE DISTRICTS AND VARIETIES IN THE UNITED STATES



THREE TYPES of grapes are grown in the United States. In the order of economic importance they are the vinifera, the American euvitis, and the muscadine.

This bulletin sets forth in a general way the main geographic regions where these are found and makes recommendations as to the specific districts where each kind can be grown to advantage. A map of the United States showing the outlines of these 13 districts is included.

A large number of varieties of grapes are described, and the importance of selecting the right ones for planting under various climatic and soil conditions is emphasized.

Washington, D. C. Issued April, 1932

GRAPE DISTRICTS AND VARIETIES IN THE UNITED STATES

By George C. Husmann, *formerly Pomologist, Division of Horticultural Crops and Diseases, Bureau of Plant Industry*

CONTENTS

Page
Introduction ... 1
    Vinifera type ... 1
    American euvitis type ... 3
    Muscadine type ... 3
Soils ... 4
Vineyard sites ... 4
Planting and cultural methods ... 6
    Vinifera vineyards ... 6
    American euvitis vineyards ... 8
    Muscadine vineyards ... 8
    Tools and implements ... 8
Districts and suitable varieties ... 9
    District No. 1 ... 10
    District No. 2 ... 11
    District No. 3 ... 11
Districts and suitable varieties—Continued.
    District No. 4 ... 12
    District No. 5 ... 12
    District No. 6 ... 13
    District No. 7 ... 13
    District No. 8 ... 13
    District No. 9 ... 14
    District No. 10 ... 14
    District No. 11 ... 14
    District No. 12 ... 14
    District No. 13 ... 15
Brief descriptions of the varieties ... 15
    Vinifera type ... 16
    American euvitis type ... 20
    Muscadine type ... 31

INTRODUCTION

Grape growing in the United States at the present time is almost entirely confined to three main types of grapes. In the order of their economic importance these are the vinifera, grown for the most part west of the Rocky Mountains and almost entirely in California; the American euvitis (various species of Vitis, subgenus Euvitis), grown in the region east of the Rocky Mountains and bordering on the Great Lakes, north of the Ohio River and west of the Mississippi to the one-hundredth meridian; and the muscadine, grown in the entire Atlantic coastal plain from the James River in Virginia to Florida, reaching well up into the Blue Ridge Mountains, along the Gulf coast to Texas, and northward along the Mississippi River to southeastern Missouri and the Tennessee River.

VINIFERA TYPE

The successful growing of grapes of the vinifera type (*Vitis vinifera*) is due largely to favorable climatic factors, including rarity of severe frosts, sufficient heat, dry air during the hotter part of the growing season, and absence of very low winter temperatures. These conditions, especially the dry growing season, reduce the development of the fungous diseases to which many of these varieties are supposed to be very susceptible and which, where prevalent, prevent commercial production.

Vinifera varieties may be grown in some parts of the American native-grape region if given special care and attention. However, in the greater part of the eastern United States the summers are too short or too humid for best commercial production.

Through the centuries of their culture in Europe, the vinifera varieties adapted themselves to or were developed to meet the various soil and climatic conditions in European countries. These varieties were introduced into the Colonies as the basis for the earliest attempts at grape growing there. But in the East they soon succumbed to attacks of phylloxera found on the native vines and to the fungous diseases which the climate encouraged. In the West, on the other hand, they found congenial climatic conditions[1] in the deserts and valleys and on the hillsides and mountain tops of California. (Figs. 1 and 2.) Even here, however, they show marked differences in behavior and value under the different soil and climatic conditions of the region.

There was a revival of interest in the cultivation of vinifera grapes in the eastern United States, when phylloxera-resistant stocks, on which they could be grafted, were developed.

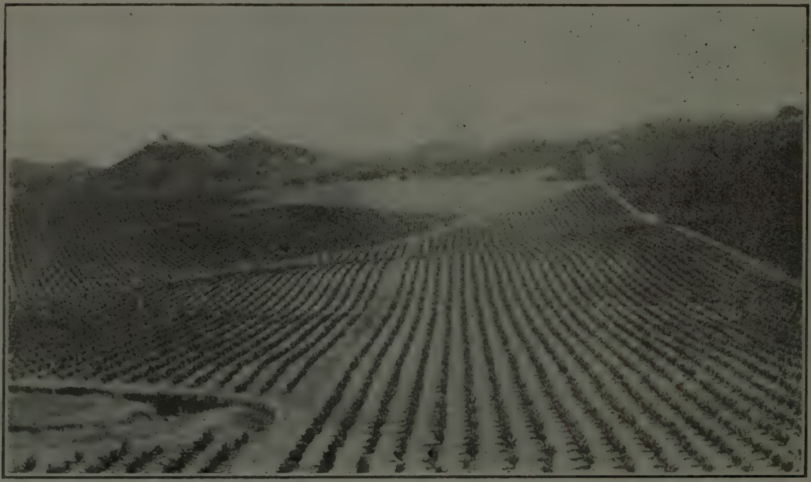


FIGURE 1.—Vinifera vineyards in the foothills of Sonoma County, Calif.

The *Phylloxera vitifoliae* was accidentally introduced into California, and its attacks there have made it advisable to grow all vinifera varieties on the phylloxera-resistant stocks. Establishment of such vineyards costs more, but the vines are more permanent and can be grown in many localities where own-rooted vines would not thrive.

The principal vinifera varieties that have been grown in this country are the Alexandria, Alicante Bouschet, Black Hamburg, Burger, Cabernet Sauvignon, Carignane, Chasselas de Fontainebleau, Cinsaut, Dodrelabi, Emperor, Flame Tokay, Green Hungarian, Grenache, Listan, Malaga, Mission, Mondeuse, Mourastel, Muscadelle du Bordelais, Olivette Blanche, Olivette Noire, Pedro Ximines, Petit Syrah, Pineau de Chardonnay, Purple Damascus, St.

---

[1] For information on adaptability and congeniality of grape varieties consult the following publications: U. S. Department of Agriculture Bulletin 209, Testing Grape Varieties in the Vinifera Regions of the United States; U. S. Department of Agriculture Technical Bulletin 146, Testing Phylloxera-Resistant Grape Stocks in the Vinifera Regions of the United States.

Macaire, Sauvignon Vert, Semillon, Sultana, Sultanina (*Thompson Seedless*), Sylvaner, Traminer, Valdepenas, Veltliner, Vermentino, and Zinfandel.

AMERICAN EUVITIS TYPE

The grapes designated in this bulletin as American euvitis have been derived for the most part from native species of bunch grapes or hybrids between them and the European or vinifera grapes. They can be grown over a wide range of territory and on a great diversity of soil types. There are few localities of this country to which some variety of this group is not adapted. In congenial conditions they also prove highly resistant to phylloxera.

At present nine-tenths of the plantings of American euvitis are of the Concord variety. The next most important variety is the Delaware. Other varieties that have been grown more or less extensively are the Agawam, Barry, Brighton, Brilliant, Campbell, Carman, Catawba, Champenel, Clevener, Clinton, Cynthiana, Diamond, Diana, Dutchess, Elvira, Eumelan, Goethe, Herbemont, Herbert, Isabella, Ives, Jefferson, Lenoir, Lindley, Missouri Riesling, Montefiore, Moore, Niagara, Noah, Norton, Pierce, Salem, Wilder, Winchell, Worden, and Wyoming.

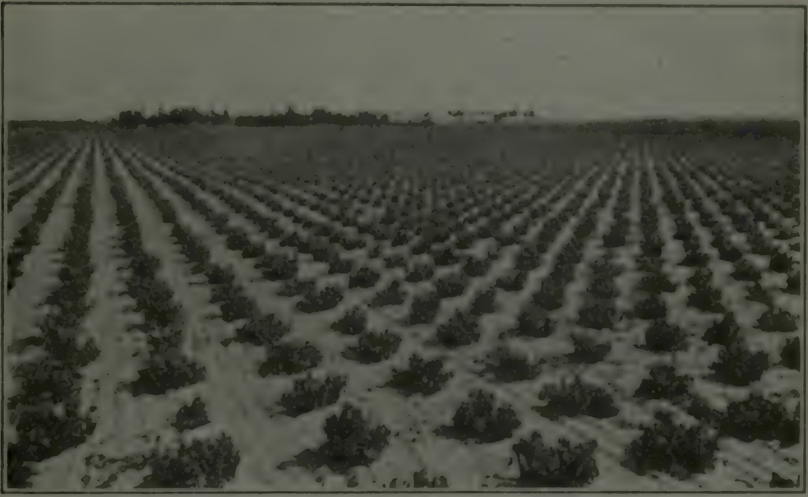


FIGURE 2.—Vinifera vineyards in the San Bernardino Desert, Calif.

MUSCADINE TYPE

The varieties of the muscadine type are those derived from the native species, *Vitis rotundifolia.* They are resistant to phylloxera, and after the fruit has set they are particularly resistant to fungous diseases, which accounts for the early and continued use of muscadines in farm homes throughout the region.

The Scuppernong has been grown more extensively than any other muscadine variety. Other varieties grown to some extent are the Eden, Flowers, James, Memory, Mish, and Thomas.

The trend of the grape industry in the United States since 1900, in so far as the distribution and extent of vineyards are concerned, has been for the most part steadily upward in the important muscadine and vinifera grape-growing States. Since 1920 Arkansas and Missouri have added large numbers of vines and California has more than doubled its acreage until it now produces more than 90 per cent of all the grapes grown in this country. To offset these increases, however, there have been decided decreases in the vine population of some of the formerly important producing States in the American euvitis region.

Information on the propagation, pruning, and training of grapes may be found in United States Department of Agriculture Farmers' Bulletin 471. Information on the insect and fungous enemies of grapes may be found in Farmers' Bulletin 1220, Insect and Fungous Enemies of the Grape.

SOILS

Improved varieties and hybrids have been developed from a large number of native grape species having a wide range of adaptation to soil and climatic conditions. For commercial production, lands that are easy to cultivate and will produce large crops are usually selected. Although many acres of soil, unsuited for other crops, will produce fair yields of grapes, the grape responds as generously to good soil and good treatment as does any other fruit grown.

Grapevines will grow on soils ranging from sandy loam to heavy clay. Gently sloping, well-drained calcareous loams of sufficient depth that are easily worked, fertile, but not excessively rich, and are underlain by an open porous subsoil, and sandy soils with a gravelly substratum are most favorable. Fairly deep clay-loam soils, underlain with subsoil that permits the vine roots (fig. 3) to penetrate, also give good results; however, if they are to be friable and pulverize well such soils must be plowed and cultivated when neither too wet nor too dry. Stony land on which general farming is impracticable but where vines can be cultivated will render fair returns from grapes only if the soil is loose and sufficiently deep for the roots to penetrate it and if plenty of fertilizer and humus are added. It is important that the subsoil be loose and porous, to permit the escape of surplus water and to allow the roots of the vines to penetrate. The surface soil can be changed and modified by cultivating and fertilizing, but the subsoil can not.

In soils excessively rich in humus and nitrogenous matter, as on many river and creek bottom lands, the vines make rank wood growth but the fruit is mediocre. On the other hand, sterile soil will not produce thrifty vines or heavy grape crops.

VINEYARD SITES

If the vines are planted only to yield a supply of grapes for home use they will naturally be placed in some convenient location near the house. Possibly they will overrun porches or arbors, furnishing shade and ornament as well as fruit. If their location is chosen from the viewpoint of convenience or beauty rather than soil suitability they may require more care and fertilizer to compensate for soil deficiencies.

When grapes are to be grown for commercial purposes, the location of the vineyard should be carefully chosen. Other things being equal, gradual slopes to the south and east are favorable for early growth and maturing of fruit. If practicable, the rows should be

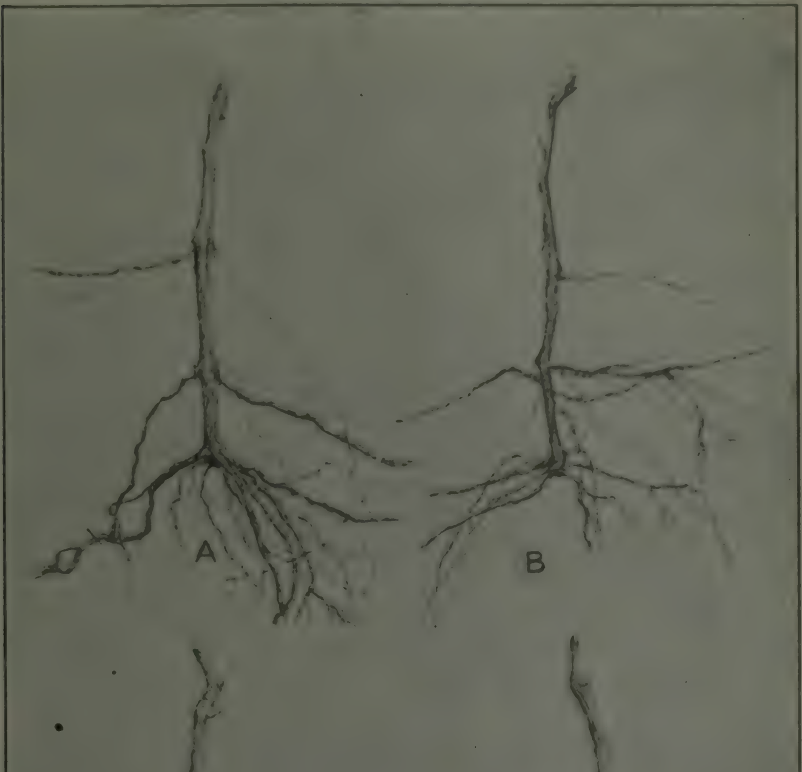


FIGURE 3.—Various types of root systems: A, Roots of the fleshy type; B, roots of the shallow or spreading type; C, roots of the deep-striking type; D, roots of the oblique type. Markings on A show how vine should be pruned for planting

run north and south so that the tops of the vines will shade and protect the trunks from sun scald. Hillside locations may be selected, those subject to serious washing being avoided. To prevent erosion, it is often advantageous to run the vine rows parallel with the contour of the hill.

Good air and water drainage are essential. It is also very important that the vineyard site be free from late spring frosts.

The local warm and cold air currents, especially in a hilly country, are more apparent at night and can best be discovered by going over the site at that time. Markets, labor supplies, and location of shipping points are important considerations in locating and establishing vineyards.

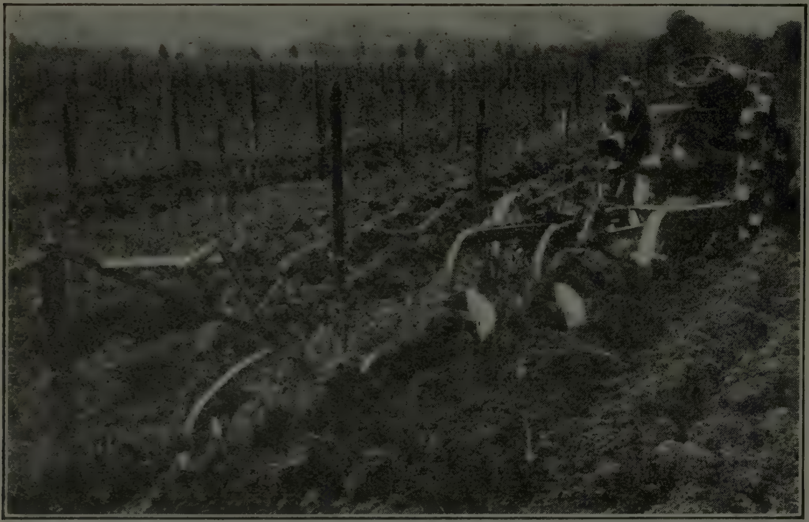


FIGURE 4.—Untrellised vineyard. First plowing, throwing soil away from the vines

PLANTING AND CULTURAL METHODS

VINIFERA VINEYARDS

Vinifera grapes are now set out 8 by 8, 9 by 9, 8 by 10, or 8 by 12 feet apart. The former practice was to set them 7 feet apart each way, and support them by stakes. Cane or spur-renewal pruning and training the vines to stakes are now practiced with most varieties, exceptions being the Sultanina and Emperor, which are pruned to a 4-arm renewal system and trained on a 2-wire upright trellis. Untrellised vineyards are cross-plowed and cross-cultivated. The soil is thrown away from the vines (fig. 4) in the first plowing, and thrown up to them (fig. 5) in the second. After the second plowing, cross disking and pulverizing (fig. 6) complete the cultural work of the season.

The important vinifera districts in California have distinct rainy and dry seasons. The rainy season usually commences about November 1, and showers may continue until about May 15. The pruning, planting, and cultural work is done during this time. Because of the almost complete lack of rain during the remainder of the year, cultivation in California practically ceases with the end of the rainy season.

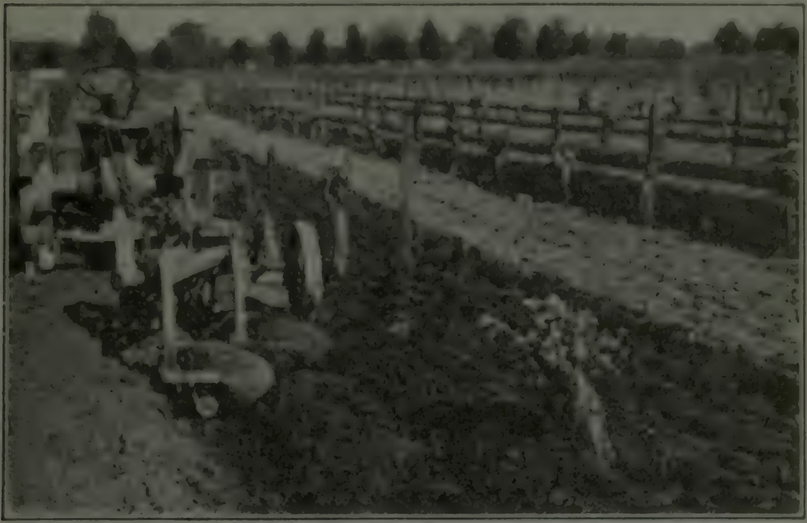


FIGURE 5.—Untrellised vineyard. Second plowing, throwing the soil up to the vines

The native bunch grapes or American euvitis varieties are planted 8 by 10, 8 by 12, 9 by 9, or 9 by 12 feet apart. Being trained on trellises, such vineyards can not be cross-plowed or cross-cultivated as can the untrellised vinifera vineyards in California. In the past these grapes usually were pruned to the 4-arm renewal system and trained to a 2-wire upright trellis. In recent years the modified Munson system (fig. 7) appears to be gaining in favor.

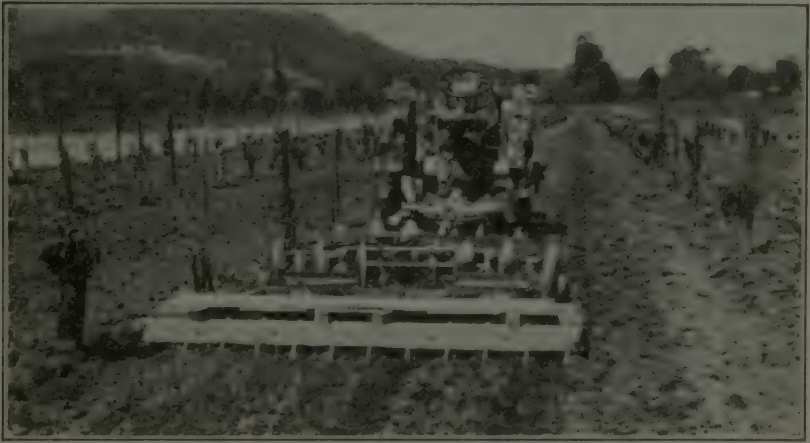


FIGURE 6.—Untrellised vineyard. Cross disking and pulverizing after second plowing finishes the cultural work of the season

These grapes are cultivated in practically the same manner as the vinifera type, except that continued cultivation and weed control throughout the summer are necessary because rainfall continues in the summer in the region in which they are grown. (Fig. 8.)

AMERICAN EUVITIS VINEYARDS

MUSCADINE VINEYARDS

Muscadine grapes for family use usually are grown on arbors near the house. When grown commercially they are generally trained to a horizontal (fig. 9) or overhead system by which the growth is spread as an overhead canopy about 7 feet above the ground and supported by posts, the vines usually being planted 20 feet apart each way. In some vineyards the vines are trained to an upright trellis, in which case they are usually planted 10 or 12 feet apart.

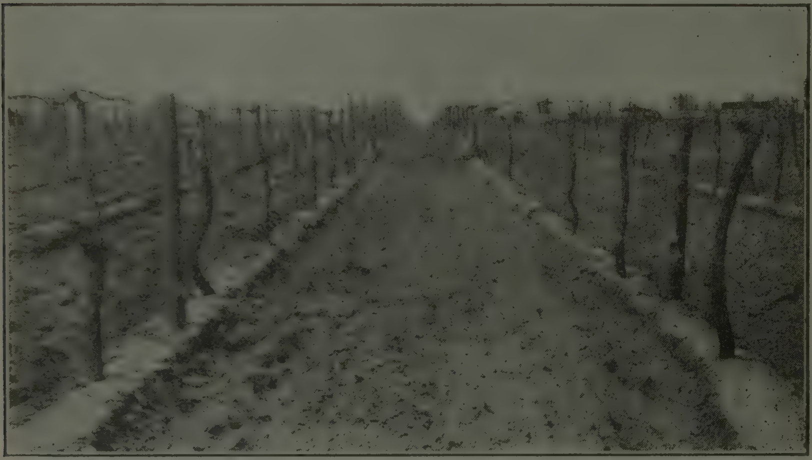


FIGURE 7.—Vineyard of American euvitis or native bunch grapes after first plowing. Row on left trained to 4-arm renewal system. Row on right trained to modified Munson system

Because of the climatic conditions in the region in which they are grown, the muscadine grapes, like the native bunch grapes, must be cultivated throughout the summer. If the vines are grown as overhead canopies cross-plowing and cross-cultivation can be carried on underneath them, but if they are trained to upright trellises the work must be done between the rows.

TOOLS AND IMPLEMENTS

The cultural implements used are similar for all three types of grapes. In California, where the vineyards are much larger than elsewhere in the United States, tools and implements are purchased especially for grape cultivation. The regular cultural implements in general farm use are employed in the other grape-growing areas.

DISTRICTS AND SUITABLE VARIETIES

Soil and climate are the two most important factors governing grape culture and distribution. The large number of indigenous grape species of the United States shows this. They outnumber the species so far discovered in all the rest of the world, and each has definitely adjusted itself to certain soil, climatic, and other conditions and will thrive only under those conditions.

Varietal recommendations in this publication are based upon a knowledge of the adaptability of the parent species of the varieties discussed; upon varietal studies carried on in the numerous experimental vineyards located by the United States Department of Agriculture, from time to time, in the various important grape districts of this country; upon cooperative investigations carried on with State agricultural colleges and State agricultural experiment stations; upon the reports of growers to whom the department has distributed grape varietal material for testing; and upon extensive travel and studies made throughout the country.

FIGURE 8.—American euvitis or native bunch grape vineyard in summer after the soil has been plowed up to vines and cultivated

In discussing adaptability of grape varieties to different portions of the United States a map (fig. 10) is used, which shows 13 main districts. Varieties likely to succeed are suggested for each district.[2] Arbitrary lines indicate the approximate boundaries of these districts, but in fact there is a gradual shading of each district into the others adjacent. Each district includes localities in which grapes are subject to injury from late spring frosts or which for other reasons are not suited for vineyard purposes. Each district also includes localities particularly suitable for special lines of grape growing.

Large bodies of water modify climatic conditions along their shores in such a way as to encourage grape growing. This is demonstrated along the shores of Lake Ontario. Lake Erie, and smaller lakes in New York; along the shores of Lake Erie in Pennsylvania and Ohio; along the shores of Lake Michigan and smaller lakes in Michigan. Altitude also has its influence. On the mountain sides throughout an area in southwestern North Carolina, northwestern South Carolina, and northern Georgia there are thermal belts in which vinifera varieties, principally successful in California, can be grown. On other lands, adjacent to the thermal belts mentioned, but not having the same conditions of temperature, these varieties will not grow well.

---

[2] Varieties particularly useful for juice purposes are indicated by asterisks (*).

Changes in cultural practices and the development of irrigation have a far-reaching influence on the possibilities of grape culture. Irrigation made possible the raisin industry in California, now the largest in the world. Through it the Imperial Valley, formerly a hot desert waste in Imperial County, has become an early-grape producing section; in southern Arizona grape districts are developing, and in Idaho, Colorado, New Mexico, and the eastern portions of Oregon and Washington (roughly indicated by cross-lined patches in fig. 10), grape growing can now be successfully carried on. In fact, in nearly any arid part of the United States it is possible to grow, under irrigation, at least enough grapes for family use.

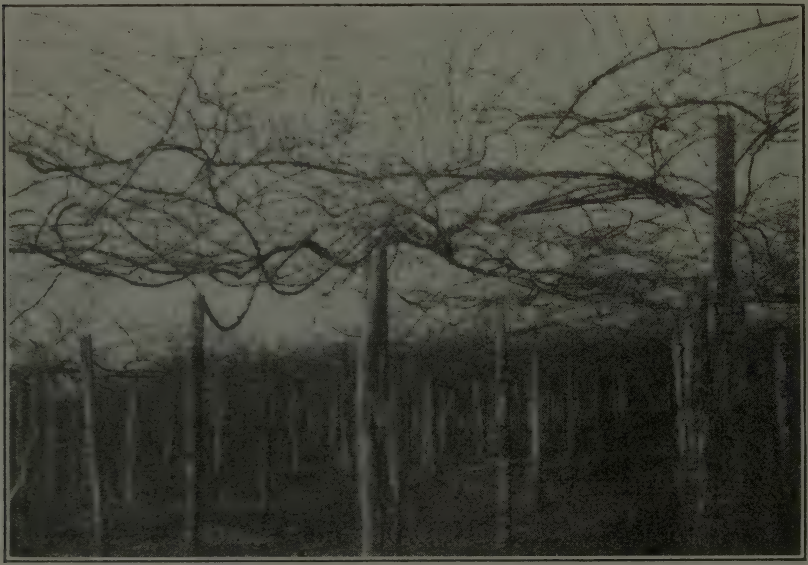


FIGURE 9.—Muscadine vineyard trained to horizontal overhead system

DISTRICT NO. 1

This district takes in the northern portions of Maine, New Hampshire, Vermont, New York, Michigan, Wisconsin, Minnesota, and South Dakota, all of North Dakota, and all but the extreme western part of Montana. It is characterized by low winter temperatures and a comparatively short growing season. Minnesota, South Dakota, North Dakota, and Montana are further characterized by drying winds and droughts. Only very hardy, early-ripening varieties, such as the Alpha*, Beta*, Dakota*, Hungarian, Janesville*, Monitor*, and Suelter, are at all worthy of trial.

DISTRICT NO. 2

This is the most important district growing improved varieties of American euvitis, their hybrids, and hybrids between them and the vinifera species. On the shores of the important lakes in this district are the largest acreages and the greatest commercial production of such grapes. It comprises most of New England and New York; the northern portions of New Jersey, Pennsylvania, Ohio, and Indiana; most of Michigan; and the northern half of eastern Illinois. The varieties suggested for this district are: White—Diamond, Empire State, Niagara, and Winchell*; red—Agawam, Brighton, Catawba, Delaware*, Goethe, Lucile, and Goff; black—Campbell, Concord*, Ives*, Moore, and Worden.

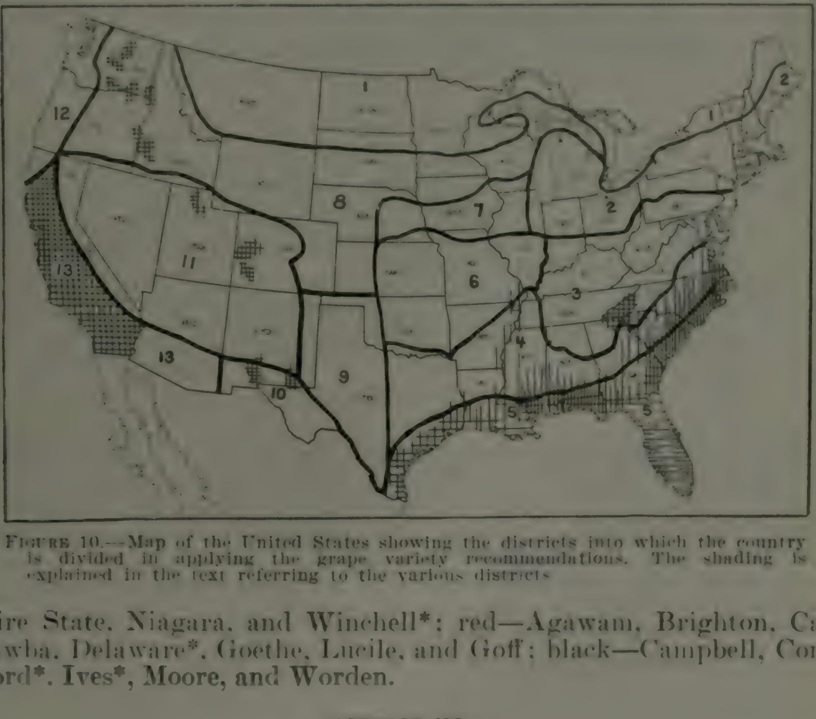


FIGURE 10.—Map of the United States showing the districts into which the country is divided in applying the grape variety recommendations. The shading is explained in the text referring to the various districts

DISTRICT NO. 3

In area this is one of the largest of the native American euvitis districts, comprising all of Delaware, Maryland, and West Virginia; most of Virginia, Kentucky, and Tennessee; the southern portions of New Jersey, Pennsylvania, Ohio, and Indiana; the western portions of North Carolina and South Carolina; and the northern portions of Georgia and Alabama. Soil and climatic conditions in this district differ greatly.

Varieties suggested for this district are: White—Diamond, Elvira*, Empire State, Hidalgo, Niagara, Rommel, Winchell*, and Wapanuka; red—Agawam, Brighton, Brilliant, Catawba*, Delaware, Goethe, Lucile, and Goff; black—Campbell Early, Carman, Concord*, Cynthiana*, Hernito, Hubbard, Husmann, Ives*, Lenoir*, Moore Early, Norton*, and Worden. It is believed that within the cross-lined area shown on the map in this district there are thermal locations where vinifera varieties grafted on phylloxera-resistant stock can be successfully grown in addition to American euvitis.

DISTRICT NO. 4

Beginning in southeastern Virginia, this large district extends through the central portions of North Carolina, South Carolina, Georgia, Alabama, and Mississippi; western Tennessee and Kentucky; southeastern Missouri; eastern and southern Arkansas; southern Oklahoma; the northern half of Louisiana; and all of eastern Texas except that portion bordering on the Gulf of Mexico. It is characterized by long, hot summers, and owing to its extent great differences are found in its winter climate and in its soils. Varieties suitable for the eastern and western portions are given separately, for the sake of greater accuracy.

Eastern portion: White—Diamond, Empire State, Elvira*, and Niagara; red—Agawam, Brighton, Brilliant, and Delaware; black—Concord*, Carman, Lenoir*, Moore Early, and Hubbard. Where the lined portion of the map extends into this district the varieties of the muscadine group, including Thomas, James, Eden, Flowers, Mish, and Scuppernong, also succeed.

Western portion: White—Gold Coin, Wapanuka, Winchell*, and Rommel; red—Headlight, Brilliant, Brighton, and Last Rose; black—Husmann*, Fern Munson*, Moore Early, and Carman.

DISTRICT NO. 5

This district includes the entire southeastern coastal plain south and east of district 4 from the James River in Virginia to and including Florida, thence along the Gulf coast to the Rio Grande. The muscadine groups are native here, and the soil, climatic, and other conditions are particularly suited to them. Since they will produce some fruit with practically no care, culture, training, or pruning, and because of their resistance to prevalent fungous diseases so common to euvitis, muscadine varieties have been the leading grapes in this section since the earliest white settlements were made. In Figure 10 vertical lines show where *Vitis rotundifolia* is native, horizontal lines where *V. munsoniana* is native, and crosslines near and along the Gulf coast, where *V. rotundifolia* can be grown. The Scuppernong is the only listed light-colored variety, and is more extensively grown than all the other catalogued varieties combined. The better catalogued dark-colored sorts are: Eden, Flowers, James, Memory, Mish, and Thomas, all of which are pistillate and should be interplanted with a sufficient number of staminate vines to pollinate them.

Euvitis varieties suggested for this district are: White—Wapanuka, Hidalgo, Niagara, and Krause; red—Ellen Scott, Captivator, Last Rose, Delaware, and Valhallah; black—Beacon, Cloeta, and

Carman. By adopting special methods of training and by grafting on phylloxera-resistant stocks, certain vinifera or European grape varieties have been grown. However, they are not recommended for general planting in this district.

DISTRICT NO. 6

This district includes the southern half of Illinois, most of Missouri, the northwestern half of Arkansas, the northern and eastern part of Oklahoma, all of eastern Kansas, and a corner of southeastern Nebraska. It has rather hot summers and fairly cold winters; it varies from rolling prairies to rather pronounced mountain areas. It includes a considerable number of this country's most important rivers.

The following varieties are suggested for it: White—Diamond, Elvira*, Empire State, Hidalgo, Niagara, Rommel, and Winchell*; red—Agawam, Brighton, Brilliant, Catawba, Delaware*, Goethe, Goff, and Lucile; black—Campbell Early, Concord*, Cynthiana*, Hernito, Hubbard, Husmann, Ives*, and Moore Early.

DISTRICT NO. 7

This district embraces the extreme southern portion of Wisconsin, northwestern Illinois, eastern and southern Iowa, and the central portion of eastern Nebraska—a rather rolling open country, having rather severe winters and a moderately long growing season.

Varieties that may be grown successfully are: White—Diamond Elvira, Empire State, Niagara, and Winchell*; red—Brighton, Delaware*, Goff, and Lucile; black—Campbell Early, Concord*, Hernito, Ives*, Moore Early, and Worden.

DISTRICT NO. 8

This district embraces northeastern Michigan; northern Iowa; central Wisconsin; southern Minnesota and South Dakota; almost all of eastern Oregon, eastern Washington, and eastern Colorado; western Montana, Nebraska, and Kansas; and almost all of Wyoming and Idaho. It is larger than any other district and varies much in soil, climatic, and other conditions. It is characterized by low winter temperatures and drying winds, a large part having very limited rainfall. No part is particularly well adapted to grape growing, and in it only the very hardy varieties have a chance of succeeding. Those for the eastern and western portions are stated separately.

Eastern portion: White—Diamond, Elvira, Niagara, and Winchell*; red—Brilliant, Delaware*, and Goff; black—Concord*, Ives*, Lenoir*, Moore Early, and Worden.

Western portion: White—Diamond and Winchell; red—Agawam, Goff, Delaware*, and Vergennes; black—Concord*, Isabella, and Worden.

Attention is called, however, to some localities in the western portion of this district in which the choicer and more tender grapes, including the vinifera varieties, can be grown under irrigation if the vines are winter covered. Six of these localities are in Washington, Oregon, and Idaho. They are indicated by crosslines in Figure 10

DISTRICT NO. 9

This district, a portion of the southern Great Plains area, includes the central part of Texas, western Oklahoma, and eastern New Mexico. It is characterized by comparatively high altitude, limited rainfall, and rather constant winds.

The following varieties are suggested as likely to succeed in it: White—Gold Coin, Hidalgo, Krause, Rommel, and Wapanuka; red—Captivator, Delaware*, Ellen Scott, Last Rose; black—Bailey*, Beacon, Carman, Cloeta, Herbemont*, Husmann, Lenoir*, and Manito.

DISTRICT NO. 10

District No. 10 includes only southern New Mexico and the extreme western portion of Texas. Its winter temperatures are not very low. Indicated on the map as cross-lined patches, there are some irrigated districts in the Rio Grande and Pecos Valleys of New Mexico and in the El Paso section of Texas in which a few vinifera varieties are grown, the Mission being the principal one. Sultanina (*Thompson Seedless*), Sultana, Alexandria, Black Hamburg, and other varieties have been tried there and might succeed, especially if given winter protection.

DISTRICT NO. 11

This district comprises western Colorado, the northwestern half of New Mexico, the northern half of Arizona, all of Utah and Nevada, and the mountainous portion of eastern California. It varies exceedingly—from snow-capped mountains of high altitude to irrigated valleys. In the dry-land areas conditions are adverse to grape culture and are prohibitive at altitudes exceeding 7,000 feet. Commercial grape culture should not be attempted in this district except in irrigated localities free from alkali. Two such localities in Colorado and one in Utah are shown on the map.

If grafted on phylloxera-resistant stocks, the more hardy vinifera varieties can probably be grown in this district, especially if winter protection be given them. These include such sorts as Black Hamburg, Chasselas de Fontainebleau, Flame Tokay, Jura Muscat, Sylvaner*, and Zinfandel*.

American varieties (which should need no winter covering) suggested for trial planting are: White—Diamond, Niagara, and Winchell*; red—Brighton, Goff, and Delaware*; black—Concord*, Isabella, and Worden.

DISTRICT NO. 12

This district embraces the extreme northwestern portion of California, western Oregon, and western Washington. Such vinifera varieties as Black Hamburg, Chasselas de Fontainebleau, Flame Tokay, Jura Muscat, Sylvaner*, Sauvignon Vert*, and Zinfandel* have succeeded in the Willamette Valley and in southwestern Oregon.

The prevailing conditions, however, indicate that better results would be obtained with improved American varieties. Suggested for trial planting in this district are: White—Diamond, Niagara, and Winchell*; red—Agawam, Brighton, and Delaware*; black—Concord, Campbell Early, and Worden.

DISTRICT NO. 13

With the exception of a number of developments in the southern portion of Arizona in recent years, the grape production of district No. 13 is located entirely in California.

In the southern part of this district, and in the southern half of California, which includes the principal raisin-producing section, the following are the important varieties grown: Muscat of Alexandria*, Sultanina* (*Thompson Seedless*), Malaga, Listan (*Golden Chasselas*), Zinfandel*, Alicante Bouschet*, Feher Szagos*, Emperor, Sultana*, Mission*, Panariti*, Ohanez, Hunisa, and Castiza.

From the central portion of California to and including the northern end of district No. 13, the choicest varieties for table, storage, juice purposes, and shipping grapes have been grown, among the more important being Alicante Bouschet*, Calmette*, Carignane*, Black Hamburg, Black Prince, Burger*, Cabernet Sauvignon*, Chablis*, Chasselas Dorè, Chauche Gris*, Chauche Noir*, Cinsaut, Cornichon, Ferrara, Flame Tokay, Green Hungarian*, Grenache*, Gros Guillaume, Mataro*, Mission*, Mourastel*, Muscateller, Olivette Blanche, Ohanez, Panariti*, Pedro Ximines*, Petit Syrah*, Prune de Cazouls, Sauvignon Vert*, Semillon*, Sultanina*, Sylvaner*, Valdepenas, Veltliner*, and Zinfandel*.

Under present conditions the following varieties are suggested for the various purposes for which grapes are now used. For juice purposes—Petit Syrah*, Grenache*, Carignane*, Alicante Bouschet*, Mission*, and Palomino*; for juice and table-grape purposes—Gros Guillaume, Prune de Cazouls, Black Hamburg, Muscat Hamburg, Black Prince, and Alexandria; for shipping—Castiza, Gros Guillaume, Ohanez, Emperor, Cornichon, Olivette Blanche, Muscat Hamburg, Monukka, Prune de Cazouls, Terret Monstre, and Red Muscat; for raisins—Alexandria, Monukka, and Sultanina; for currants—Panariti.

BRIEF DESCRIPTIONS OF THE VARIETIES

There are four kinds of flowers in grapes: The practically pistillate or female flowers with weak, recurved stamens, which usually do not produce viable pollen (varieties producing such flowers are self-sterile); staminate or male flowers with abundance of virile pollen but with abortive pistils, nonfruitful; perfect or hermaphrodite self-fertile flowers; and gradations among these three classes, presenting varying degrees of self-sterility or fertility.

For home plantings of the American native bunch grape sorts that usually are self-fertile or an assortment of varieties are suggested. Their flowering characteristic is seldom an important consideration. If, in commercial grape growing, it is desired to produce a special variety which is self-sterile, the vines must be interplanted with varieties blossoming at the same time and having an abundance of virile pollen. One such vine usually is sufficient to pollinate 10 self-sterile vines. The following brief descriptions of grape varieties cover both the self-fertile and self-sterile varieties. These descriptions not only mention specifically the districts in which each variety can be grown, but indicate the special merit or importance of each variety and state whether it is commercially grown.

The sugar content in the expressed juice, as determined by Balling-scale readings, is given when available. Several readings for each vinifera variety were obtained through several seasons, and the range of the tests is given. Sugar readings for the same variety will differ from year to year and under different growing conditions. Therefore, the range within which the readings on the variety are likely to fall is given.

For the American euvitis and muscadine grape varieties a single reading, representing the average of a number of Balling-scale determinations, is given. It is believed that these readings represent approximately the average for well-grown, well-matured, typical grapes of each variety. The same applies to the acidity readings, which are expressed as tartaric acid in grams per 100 cubic centimeters.

J. S. Caldwell and others have shown that the specific gravity of the juice as read on the Balling scale is not an exact measure of the sugar content of the juice, considerable differences being noted sometimes between Balling-scale readings and actual chemical determinations. However, Balling-scale readings are widely used, especially in California, as a measure of maturity and quality in grape varieties, even though they do not accurately measure the sugar content.

VINIFERA TYPE

Because none of the vinifera varieties resist the *Phylloxera vitifoliae*, all will need to be grown by grafting on phylloxera-resistant stocks.

WHITE VARIETIES

Alexandria.—Syn., *Muscat of Alexandria.* (Vin.) Origin, Africa. Vine a robust, medium, stocky grower, productive, but does not always set well. Flowers self-fertile. Cluster straggling, long, loose, never compact even when perfect; peduncle long, reddish brown. Berry large, ellipsoidal, surface smooth, yellowish green, bloom white; adherence excellent. Skin tough and thick. Flesh meaty, firm, fairly juicy. Flavor aromatic, musky, fruity, and rich; quality excellent. Sugar 19° to 29° Balling; acid 0.46 to 0.66. Ripens midseason. This is the most important raisin variety, also a very important shipping grape, as it carries well, looks well, and its peculiar muscat flavor is much admired. It seems to have been first cultivated by the Arabs. Suggested for districts 10 and 13.

Ohanez.—Syn., *Almeria.* (Vin.) Origin, Spain(?). Vine a robust, stocky, open, vigorous grower. Very productive, but not self-fertile and should be interplanted with a pollinizer. Cluster medium to above medium and uniform in size, fairly loose to compact; globose, conical, occasionally shouldered; peduncle long and stout. Berry medium to large, persistent and firm, oval, often slightly flattened at both ends, dull yellowish green with occasional brownish markings on sunny side. Skin medium thick, tenacious, adheres to pulp. Flesh greenish white, tenacious, firm; when fully ripe of good quality. Flavor indifferent sweetwater. Sugar 20° to 24° Balling; acid 0.56 to 0.90. Ripens late. Noted for superior shipping and storage qualities, which make it exceedingly valuable, but should be grown for no other purpose. Suggested for district 13.

Olivette Blanche.—(Vin.) Origin, France. Vine a vigorous spreading grower, productive. Flowers self-fertile. Cluster large to very large, triangular and cylindrically tapering, sometimes slightly shouldered, medium loose but well filled, peduncle rather thin and long. Berries oval, medium to above medium in size, color light yellow, flushed light brown on sunny side, bloom white, heavily veined, slightly transparent, persistent, rather firm. Skin thin, tough, adheres slightly to pulp. Flesh meaty, moderately firm, juicy, somewhat coarse-grained. Flavor fruity, pleasant, sprightly, with slightly milky after-taste. Sugar 20° to 24° Balling; acid 0.53 to 0.90. Ripens medium late. A valuable shipping grape of attractive appearance and good keeping qualities. Also makes a good raisin. Suggested for districts 10 and 13.

Palomino.—Erroneously *Golden Chasselas*. (Vin.) Origin, Spain. Vine vigorous, rather strong grower, very productive. Flowers self-fertile. Cluster large, conical, loose, somewhat limby. Berries above medium to large in size, slightly oblate, light green to yellow, transparent; adherence good. Skin medium thick and medium tough. Flesh fairly meaty, rather soft, juicy. Flavor sweetwater, rich; quality very good. Sugar 21° to 25.6° Balling; acid 0.35 to 0.67. Ripens midseason. An all-around good grape, which has been very extensively grown for white-juice purposes, but also ships well. Suggested for districts 10 and 13.

Pedro Ximenes.—(Vin.) Origin, Spain. Vine a very vigorous grower and productive. Flowers self-fertile. Clusters large, cylindroconical, sometimes shouldered, loose to well filled. Berries medium to large, slightly oblong, light-green color changing to golden at maturity; bloom white; adherence excellent. Skin medium thin, tough. Flesh pulpy, fairly juicy, sweet, and of good quality. Sugar 21° to 23° Balling; acid 0.46 to 0.67. Ripens midseason. Ships fairly well and is an excellent white-juice grape. Suggested for districts 10 and 13.

Sultanina.—Syn., *Thompson Seedless*. (Vin.) Origin, Persia(?). Vine a strong, long-jointed, slender grower. Exceedingly productive. Flowers self-fertile. Cluster long, fairly loose, often fairly compact, large, from 6 to 16 inches long; peduncle 1½ to 2 inches long, medium sized. Berries oblong, above medium size, ⅝ to ¾ inch by ¾ to 1 inch; adherence good. Color light yellowish green, flushed when fully ripe; bloom white and glossy. Skin medium thick, tough. Flesh fairly meaty, moderately firm, fairly juicy; flavor sweet with delicious acidity. Sugar 22° to 27.8° Balling; acid 0.45 to 1.22. Ripens early. An excellent dessert, table, shipping, and raisin grape, popular and most valuable. The seedless-raisin grape of commerce. Suggested for districts 10 and 13.

Sultana.—(Vin.) Origin, Persia(?). Vine strong, slender; fairly long-jointed grower; productive. Flowers self-fertile. Cluster very large and loose, shouldered; peduncle rather long and slender. Berries small, globular, golden yellow; bloom white. Skin fairly thin and tough, adhering to pulp. Flesh firm, sweet, juicy, and without seeds. Sugar 23.5° Balling; acid 0.89. Ripens medium early. Noted as seedless-raisin grape, also makes a very delicate juice of straw color and great body. Suggested for districts 10 and 13.

Terret Monstre.—Erroneously *Malaga*. (Vin.) Origin, Spain(?). Vine very vigorous and very productive. Flowers self-fertile. Cluster large to very large, regularly tapering, slightly compact; peduncle solid, long. Berries large, ellipsoidal, sometimes slightly obovoid, yellowish green at ripening time with russet spots when overripe. Bloom white, adherence good. Skin thick, tough, adhering to pulp. Pulp slightly juicy, firm. Flavor sweetwater. Sugar 22.6° to 24.8° Balling; acid 0.44 to 0.65. Ripens midseason. This has been the most important white table grape grown in California. It has frequently been used as a raisin grape. Suggested for districts 10 and 13.

Panariti.—(Vin.) Origin, Greece. United States Department of Agriculture introduction No. 6429 in 1901. Vine robust, slightly spreading, dense upright grower, very productive when girdled at blossoming time. Flowers self-fertile. Cluster very long, almost cylindrical, frequently enlarged at terminal, often shouldered, sometimes winged, medium compact; peduncle medium size, long, soft, fleshy, brown. Berry globular, very small, smooth, amber, bloom white, persistent, firm, and seedless. Flesh white, soft, juicy, and of excellent quality. Flavor rich, sweet, and characteristic. Sugar 28° to 35° Balling; acid 0.57 to 0.77. Second crop clusters small, round, with large-seeded berries. Ripens very early. Best variety for curing into currants. A juicy grape of superior value. Because of its extreme earliness, rich eating quality, and seedless berries a trade outlet as a very early eating and shipping grape is possible. Suggested for district 13.

RED VARIETIES

Castiza.—Syn., *Maraville de Malaga*. (Vin.) Origin, Spain. Introduced by the United States Department of Agriculture in 1905. Vine a robust, upright, spreading grower, very vigorous and very productive. Flowers self-fertile. Clusters large to very large, fairly loose to compact, conical, gradually tapering, slightly single-shouldered and sometimes double-shouldered; peduncle stout, woody, long, light brown. Berry bright to dark red with bluish bloom, globular to oval, persistent. Skin thick, tough, adheres to pulp; pigment light red. Flesh pearly, meaty, firm, fairly juicy, and excellent in quality. Flavor fruity sweetwater. Sugar 22° to 26° Balling; acid 0.42 to 0.57. A remarkably handsome red grape of excellent merit and fine eating, shipping, and storage qualities. Suggested for district 13.

Chasselas de Fontainebleau.—(Vin.) Origin uncertain. Vine a vigorous, free grower, very productive. Flowers self-fertile. Cluster medium to below in size, long, tapering, broadly shouldered, and somewhat loose. Berries medium to below in size, globular, pale greenish yellow, transparent when fully ripe, flushed with bright cinnamon russet on sunny side. Flesh firm yet tender, juicy, sweet, and agreeable to the palate. Sugar 23° to 26.4° Balling; acid 0.46 to 0.55. Ripens medium early to midseason. The most generally grown grape in all vinifera grape-growing countries. Is a good all-purpose grape and makes a white juice of excellent quality. Suggested for districts 10 and 13.

Red Muscat.—Syn., *Red Hanepoot*. (Vin.) Origin, Africa. Vine a robust, stocky grower, very productive. Flowers self-fertile. Cluster medium loose to fairly compact, long tapering; peduncle medium to long, reddish brown. Berry large, ellipsoidal, surface smooth, yellowish red; bloom white; adherence excellent. Skin tough and thick. Flesh meaty, firm, fairly juicy. Flavor aromatic, fruity, and rich, and of excellent quality. Sugar 22° to 30° Balling; acid 0.47 to 0.67. Ripens midseason. A handsome eating and shipping grape of excellent quality. Suggested for district 13.

Emperor.—(Vin.) Origin unknown. Vine a vigorous, long, spreading grower, often very productive. Flowers self-fertile. Clusters large, pyramidal, loose to well filled; peduncle very long, medium hard. Berries large, obovoid, elongated, pulpy, medium juicy, color grizzly to dark cherry red. Skin medium thick and medium tough. Flesh greenish white, firm. Flavor indifferent. Sugar 20° to 24° Balling; acid 0.63 to 0.94. Ripens late. The Emperor is one of the leading late-shipping and storage grapes grown in California. Suggested for district 13.

Flame Tokay.—(Vin.) Origin, Algeria(?). Vine a vigorous, erect, stocky grower; very productive. Flowers self-fertile. Clusters large to very large, almost flat on end, firm, not juicy, color red. Skin medium thick, medium tough. Flesh greenish white, firm, and of fair quality when fully ripe. Flavor, indifferent sweetwater. Sugar 20.8° to 27° Balling; acid 0.48 to 0.76. Ripens midseason. A good shipping grape and should be grown for that purpose only. At present the most extensively grown shipping grape of California. Suggested for districts 10 and 13.

BLACK VARIETIES

Alicante Bouschet.—(Vin.) Origin, France. Vine a fairly vigorous trailing grower and very productive. Flowers self-fertile. Clusters rather large, well filled, and short, with heavy shoulders or wings; peduncle long and stout. Berries medium or above medium in size, round to slightly oval, firm, dull black with abundant bloom; pulp firm; juice dark red. Skin medium thick and medium tough. Sugar 20° to 24.9° Balling; acid 0.67 to 1.89. Ripens midseason. This variety is used almost exclusively for juice. Its productiveness, deep color, and good shipping qualities make it valuable for this purpose. Suggested for district 13.

Black Hamburg.—(Vin.) Origin, Austria. Vine vigorous, erect grower, very productive. Flowers self-fertile. Clusters medium to large, pyramidal, cylindrically tapering, compact; peduncle short to medium length, rather thick. Berry large, globular to slightly oval, purple with bluish bloom, meaty, persistent. Skin thick, fairly tough; pigment red. Flesh juicy, soft. Flavor sweetwater and aromatic when fully ripe. Sugar 20° to 28° Balling; acid 0.64 to 0.73. Ripens midseason. A good all-purpose grape, and adjusts itself to many diversified conditions. Perhaps the best-known vinifera variety. It has been grown more extensively under glass than any other variety. Suggested for districts 10 and 13.

Black Prince.—(Vin.) Origin, unknown. Vine strong, vigorous, very productive. Flowers self-fertile. Clusters very large, tapering regularly and gradually from the shoulder downward, sometimes almost cylindrical. Berries medium in size, ovate, dark purple with heavy bloom, persistent. Skin thick, fairly tough; pigment light red. Flesh colorless, meaty, fairly firm, juicy. Flavor fruity, sprightly, sweetwater. Ripens in midseason. A good all-purpose grape, a fair shipper, and an excellent red-juice grape. Suggested for district 13.

Carignane.—(Vin.) Origin, Spain. Vine vigorous, upright grower, very productive. Flowers self-fertile. Cluster cylindrical, with inconspicuous shoulder, compact, medium to large; peduncle medium long, light brown, woody. Berries medium sized, almost globular, dark purplish blue with abundant bloom, persistent, medium firm. Skin moderately thick, coarse, somewhat astringent. Flesh colorless, sweet, juicy, medium firm, of excellent quality. Sugar 22½° to 24° Balling; acid 0.80 to 1.29. Ripens medium late; ships fairly well. Makes an excellent red juice and is also a good all-purpose grape. Suggested for district 13.

Cornichon.—(Vin.) Origin, oriental. Vine vigorous, erect, very productive. Flowers self-fertile. Clusters large, branched, loose, with long, strong, but slender pedicels; peduncle light olive green, short, tender. Berries large, ellipsoidal, elongated, somewhat irregular, black with abundant bloom. Skin thick, meaty, tart, tough; pigment dark red. Flesh watery, meaty, firm. Flavor very pleasant and fruity. Sugar 20° to 21° Balling; acid 0.57 to 0.96. Ripens midseason. Excellent for dessert and market, passable for juice purposes. A very handsome grape of uniform-sized clusters, ships and sells well. Suggested for district 13.

Ferrara.—(Vin.) Origin, Spain. Vine vigorous and productive. Flowers self-fertile. Cluster large, conical, elongated, loose; peduncle very long, somewhat woody. Berries large, ellipsoidal, purplish black, of neutral flavor, crisp. Skin thick; pigment light red. Flesh firm, medium juicy; adherence good. Sugar 19° to 23.6° Balling; acid 0.58 to 0.76. Ripens late. Has good storage and shipping qualities. Suggested for district 13.

Grenache.—(Vin.) Origin, Spain. Vine vigorous, productive. Flowers self-fertile. Cluster large, short, compact, almost as broad as long, often heavily shouldered; peduncle large, rather hard, enlarged at cane and near cluster. Berry large, regular in size, oval, slightly flattened, dark blue. Skin medium thick, fairly tough, and contains a fair amount of dark red pigment. Juice fairly abundant, colorless. Sugar 22.5° to 24.8° Balling; acid 0.72 to 0.91. Ripens rather late. Suggested for district 12.

Gros Guillaume.—(Vin.) Origin, France. Vine a vigorous, open grower, productive. Flowers self-fertile. Cluster very uniform and medium in size, fairly loose to compact, cylindrical, ending abruptly, frequently heavily shouldered, peduncle medium in length and thickness, woody, reddish brown. Berry large, globular, sometimes slightly ovate, smooth, purple with blue bloom, dull gloss, firm, persistent. Skin moderately thick, tough, adheres slightly to pulp; pigment red. Flesh meaty, firm, juicy, excellent in quality. Flavor spicy, lively sweetwater; juice grape and excellent for dessert and shipping. Handsome, of good quality. Ripens midseason. Sugar 28° Balling; acid 0.52. A fair and excellent keeper. Suggested for district 13.

Hunisa.—(Vin.) Origin, Syria. United States Department of Agriculture introduction Nos. 6124 (in 1901) and 8583 (in 1902). Vine a vigorous, spreading grower, exceedingly productive. Flowers self-fertile. Cluster very large, long, loose, cylindrical, winged, inclined to have a considerable number of "shot" and undersized berries; peduncle medium size, wiry, olive green. Berry ovate, oblong, large to very large, purple with bluish-white bloom, glossy, firm, persistent, very handsome. Skin thick, tenacious, purple; pigment red. Flesh meaty, firm, coarse grained, moderately juicy, good quality. Flavor sprightly, sweetwater; quality very good. Sugar 21° to 28° Balling; acid 0.52 to 0.77. Ripens late. A remarkably handsome grape of excellent eating, shipping, and storage qualities. Suggested for district 13.

Jura Muscat.—(Vin.) Origin, uncertain. Vine fairly vigorous grower and very productive. Flowers self-fertile. Cluster medium in size, medium compact, tapering, cylindrical. Berry medium to below medium in size, globular, dark purple; adherence good. Skin medium thick and tough. Flesh fairly meaty, firm, medium juicy. Flavor muscat, rich; quality good. Sugar 26.5° to 28.8° Balling; acid 0.64 to 0.71. Ripens medium late. A good all-purpose grape and ships well. Suggested for districts 10 and 13.

Mission.—(Vin.) Origin, unknown. Vine robust, vigorous, very productive. Flowers self-fertile. Cluster medium to large, tapering, loose to fairly compact; peduncle slender, short, yellowish green, brittle. Berry medium size, globular, firm, black with light-blue bloom, persistent. Flesh soft, medium juicy. Skin rather thick, fairly tough; pigment light red. Flavor natural sweetwater; when fully ripe rich and sweet. Sugar 20.2° to 29.4° Balling; acid 0.46 to 0.75. A fair white or red and sweet juice grape of fair shipping quality. Vinifera grape culture in this country began with this grape. Suggested for districts 10 and 13.

Monukka.—Syn., *Black Monukka.* (Vin.) Origin, Persia(?). United States Department of Agriculture introduction Nos. 26605 and 26606 in 1910. Vine bushy, robust, drooping, dense, very vigorous, very productive. Flowers self-fertile. Clusters large to very large, loose, cylindrical, winged; peduncle light brown, rather long, strong, woody. Berries elongated ovate cylindrical with a tendency to be flattened at apex, grizzly to dark purple in color, blue bloom, dull gloss, persistent, firm. Skin moderately thin, tough, adheres to pulp. Flesh not melting, tender, juicy, firm, of excellent quality. Flavor rich, fruity, pleasant sweetwater. Practically seedless with occasional undeveloped seeds. Sugar 26° to 30° Balling; acid 0.49 to 0.59. Ripens early. Ships fairly well, its main defect being weak pedicels, which cause berries to drop if roughly handled. Makes an excellent raisin and is a fine eating grape of superior dessert quality. Also makes a good red juice. Suggested for district 13.

Muscat Hamburg.—(Vin.) Origin, probably England. Vine vigorous and productive. Flowers self-fertile. Cluster of medium size, loose, conical, long. Berry oblong, medium to above medium in size, purplish black. Adherence good. Skin medium thin but tough. Flesh fairly meaty, rather soft, juicy. Flavor muscat, vinous, rich; quality very good. Sugar 22.7° to 27° Balling; acid 0.55 to 0.71. Ripens midseason. An all-purpose grape of excellent quality. Very popular in the grapery and excellent for outdoor culture. Suggested for districts 10 and 13.

Petit Syrah.—(Vin.) Origin, French Alps. Vine a vigorous, spreading grower, very productive. Flowers self-fertile. Cluster cylindroconical in shape with shoulders or winged, medium to above medium in size, compact, black; peduncle long, rather thick, herbaceous. Berry medium and of even size, irregular in shape but somewhat elongated, black with light bloom, persistent. Skin medium thin, tough; pigment dark red. Flesh rather soft, colorless, juicy, and excellent in quality. Flavor spicy, sprightly, and rich. Sugar 18° to 25.5° Balling; acid 0.65 to 1.28. Ripens midseason. It is essentially a juicy grape, making a superior red juice. Suggested for district 13.

Prune de Cazouls.—(Vin.) Origin, France. Introduced by the United States Department of Agriculture in 1905. Vine very vigorous and very productive. Clusters uniform, medium to large, wide, intermediate in length, tapering, sometimes single shouldered, medium loose to well filled; peduncle medium short, thick, woody. Berries medium to large, slightly oblong, black covered with bluish bloom, slightly glossy, firm, persistent. Skin rather thick, medium tough, slightly adherent to pulp; pigment wine colored. Flesh pearly, juicy, fine grained, meaty, good in quality. Flavor sprightly, fruity, rich. Sugar 22° to 26° Balling; acid 0.43 to 0.82. Ripens midseason. An exceptionally handsome fine table, shipping, and storage grape. Ships, carries, and keeps well. Suggested for district 13.

Zinfandel.—(Vin.) Origin, Hungary. Vine an erect, stocky, spreading grower. Very productive. Flowers self-fertile. Clusters medium to above medium, quite full, usually heavily shouldered; peduncle medium size, woody, stocky. Berry round, medium to above medium in size, five-eighths inch in diameter, surface smooth. Skin thin, moderately tender, dark purple with heavy light bloom; pigment red. Flesh white, meaty, firm, very juicy. Flavor vinous, fruity, and spicy. Sugar 19.5° to 25° Balling; acid 0.75 to 1.11. Ripens midseason. A good eating and excellent juice grape. It has been and still is the most extensively grown vinifera red-juice grape. Suggested for districts 10 and 13.

AMERICAN EUVITIS TYPE

The cultural properties of the American indigenous grape species from which improved varieties have been developed or which have been hybridized to produce varieties now grown to some extent in the United States are given in Table 1. Knowing the characteristics of these native species and their habitat is helpful in determining the adaptability of varieties derived from them. In the following descriptions of varieties the abbreviations[a] following the varietal names show the parentage of the variety. Where known, the State and the year in which the variety was originated or discovered are stated, as well as the purposes for which the varieties are best suited and the districts to which they are best adapted.

Their parentage and the native environments under which the parent species thrive are all-important in determining the adaptability of American native grape varieties. Some cold-resistant species persist in the more northern States; others are heat resistant; still others thrive under subtropical environments or where various intermediate conditions are found.

---

[a] The abbreviations used for species of Vitis are as follows: Aest., *aestivalis*; Berl., *berlandieri*; Bi., *bicolor*; Bourq., *bourquiniana*; Cand., *candicans*; Champ., *champini*; Ci., *cinerea*; Cord., *cordifolia*; Doan., *doaniana*; Lab., *labrusca*; Linc., *lincecumii*; Sol., *solonis*; Mont., *monticola*; Rip., *riparia*; Rot., *rotundifolia*; Rup., *rupestris*; Vin., *vinifera*.

TABLE 1.—*Cultural properties of grape species used in American viticulture*

Name and region of nativity	Preferred location	Vine	Roots	Seasons of leafing, flowering, and ripening	Percentages of cuttings taking root	Grafting adaptation[1]	Resistance to—[1]				
							Phylloxera (out of a possible 20)	Cold	Dampness	Heat	Drought
Vitis aestivalis (summer grape): Southern New York to Florida westward to the Mississippi and Missouri Rivers.	Rich, warm, gravelly moist soils.	Vigorous, medium-sized climbers.	Slightly fibrous, rather large, hard, penetrating.	Medium late	50	F	14	VG	---	G	G
V. berlandieri (little mountain grape): Texas and New Mexico.	Tops, sides, and bottoms of limestone hills.	Slender, medium grower.	Slightly branching, strong, hard, plunging.	Late	40	F	19	F	----	G	G
V. bicolor (blue grape): Ontario, Wisconsin, Illinois, Indiana, Ohio, northern Kentucky, western New York and Pennsylvania, New Jersey, Maryland, and northern Virginia.	Black sand and red siliceous soils.	Fair grower	Fibrous, wiry, rather hard, large, plunging.	do	40	F	16	VG	----	G	G
V. candicans (mustang grape): Oklahoma, Texas, western Louisiana into Mexico.	Black waxy lands or adobe.	Moderately vigorous, medium climber.	Vigorous, firm, deeply penetrating.	Medium early	30	F	15	F	F	G	G
V. champini (adobe land grape): Texas	Limestone hills; adapts itself to a variety of soils.	Vigorous, spreading grower.	Large, ramified, soft, plunging.	Early to medium.	80	FB	12	F	G	G	G
V. cinerea (sweet winter or ashy grape): Illinois to Texas.	Deep, rich, loose soils on river banks.	Vigorous, strong grower.	Large, fleshy, deeply penetrating.	Very late	25	F	15	F	G	----	----
V. cordifolia (frost or sour winter grape): Great Lakes to Florida, abundant in Illinois, Tennessee, Missouri, and Arkansas.	do	Vigorous, strong climber.	Strong, hard, carneous, deeply penetrating.	Late	25	F	18	VG	F	G	G
V. doaniana (Texas Panhandle large grape): Oklahoma, Panhandle of Texas, New Mexico.	Sandy limy soils	Slender, fair grower	Fibrous, hard, deeply penetrating.		60	F	12	F	G	G	----
V. labrusca (northern fox grape): Allegheny Mountains from New England to South Carolina, Georgia, central Tennessee, southern Indiana.	Wet thickets, granitic soils.	Vigorous, medium-sized climber.	Spreading, rather large, soft, and fleshy; penetrating moderately.	Very late	85	BF	5	VG	----	F	F
V. linsecomi (post oak or turkey grape): Texas, eastern Louisiana, Oklahoma, Arkansas, and southwest Missouri.	High, well-drained timberlands, granitic, gravelly, clay, compact, deep, rich river-bank soils.	Vigorous, good-sized climber.	Large, slightly fibrous, fleshy, firm, deeply penetrating.	Medium late	40	F	14	F	----	G	G
V. longi (Solonis, bush, or gulch grape): Texas Panhandle, New Mexico, Arkansas, and Colorado.	Ravines along streams; cretaceous, generally rich sandy moist always fresh soils.	Bushy, upright, vigorous grower.	Large, slender, ramified, hard, deeply penetrating.	Early	60	F	14	F	G	G	G

V. monticola (sweet mountain grape). Texas	Low limestone hills; does moderately well in sandy soil.	Rather small; good grower.	Bushy, somewhat thick, firm, deeply penetrating.	Medium late	65	FB	18	F	...	G	G
V. rotundifolia (southern muscadine): Gulf and Atlantic States from Potomac River to central Florida, through Georgia, south Tennessee, Alabama, Mississippi, Arkansas, Louisiana, and eastern Texas.	Moist, shady places in well-drained, high bottom lands.	Slender, high climber	Thick, slightly branched, wrinkled transversely penetrating, spreading near the surface.	Very late	10		20	F	F	G	G
V. rupestris (sand, sugar, or rock grape): From the Rio Grande in Texas northeasterly into Oklahoma, northwestern Arkansas, southern Missouri, Kentucky, and Tennessee, Cumberland Mountains north to Pennsylvania.	Open places in poor soils and along gravelly banks and ravines.	Vigorous, short, bushy grower.	Long, wiry, rather slender, deeply penetrating.	Very early	80	B	19	G		G	G
V. vulpina (riparia or riverside grape): From Salt Lake east and from Texas north in all the States as far as 90 miles north of Quebec.	Moist, loose, sandy soils along creeks and river bottoms.	Vigorous, medium-sized.	Long, thin, slender, hard, wiry, ramified, spreading near surface.	do	85	FB	19	VG	G		
V. vinifera (exotic species): Finds congenial conditions in the various grape countries of the Old World.	Some varieties suited to each of the important vineyard soils.	Medium to strong grower; slender to very bushy and stocky.	Varies greatly with the various varieties.	Early to late	90			F	F	G	G

---

[1] Abbreviations used in this table: Under "Grafting," B for bench, F for field; under "Resistance," F for fair, G for good, and V for very resistant.

WHITE VARIETIES

Diamond.—(Lab., Vin.) Origin, New York, about 1870. Vine medium grower, fairly productive in nearly all locations, usually hardy as far north as latitude 42° N. Flowers self-fertile. Cluster medium to short, rather broad, somewhat blunt, cylindrical to slightly tapering, often single-shouldered, compact; peduncle short to medium, moderately thick. Berries medium to above medium in size, globular to strongly ovate on account of compactness; color green with yellow tinge covered with gray bloom; persistent, rather firm. Skin thin, rather tough, adheres to the pulp, contains no pigment, astringent. Flesh pale green, rather translucent, juicy, tender, melting, fine grained, slightly aromatic, sprightly, nearly sweet next to skin to agreeably tart at center; quality very good. Sugar 16.7° Balling; acid 0.79. Ripens medium early. A good all-purpose grape. Suggested for districts 2, 3, 4, 6, 7, 8, 11, and 12.

Elvira.—(Rip., Lab.) Origin, Missouri, 1863. Vine vigorous, hardy, healthy, exceedingly productive. Flowers self-fertile or nearly so. Cluster intermediate in size, above medium to short, of average breadth, cylindrical, usually single-shouldered, compact; peduncle short to medium, rather thick. Berries medium size, globular to slightly oblate, often misshapen on account of compactness, greenish with yellow tinge, rather dull, bloom gray, not always persistent, rather firm. Skin very thin, tender, adheres slightly to pulp, contains no pigment, somewhat astringent. Flesh greenish, juicy, fine grained, tender, slightly foxy, sweet, not acid at center, somewhat flat in flavor, of fair quality. Sugar 11.7° Balling; acid 1.04. One of the most profitable white-juice varieties. Suggested for districts 3, 4, 6, 7, and 8.

Empire State.—(Rip., Lab., Vin.) Origin, New York, about 1875. Vine a fair grower, usually healthy in most localities, somewhat tender, moderate to productive yielder. Flowers self-fertile. Cluster large to below medium, long, rather slender, cylindrical to slightly tapering, frequently single-shouldered, medium to compact; peduncle variable, often characteristically long, rather thick. Berries variable in size, averaging medium to below medium, inclined to globular, pale yellow green, gray bloom, persistent, moderately firm. Skin medium to thick, variable in toughness, adheres but slightly to pulp, contains no pigment, with slight astringency. Flesh pale yellowish green, translucent, very juicy, fine grained, rather tender, sweet next to skin but somewhat acid near center, agreeably flavored, very good in quality. Sugar 16.62° Balling; acid 0.38. Ripens midseason to late. Very much esteemed as a table grape, and in great demand for juice making. Suggested for districts 2, 3, 4, 6, and 7.

Gold Coin.—(Aest., Lab.) Origin, Texas, 1883. Vine fairly vigorous, productive, hardy as far north as latitude 43°. Flowers nearly fertile. Cluster medium to small, not very long, usually single-shouldered, variable in compactness. Berries large to below medium, globular to slightly oval, yellowish green, with a distinct trace of reddish amber, gray bloom, usually persistent. Skin covered with small scattering brown dots, thin, inclined to toughness. Flesh somewhat tough, faintly aromatic, tart from skin to center, good in quality. Sugar 15.5° Balling; acid 0.43. Fruit ripens in midseason, keeps long in good condition, and also makes an excellent white juice. Suggested for districts 4, 5, and 9.

Hidalgo.—(Vin., Lab., Bourq.) Origin, Texas, about 1895. Vine variable in vigor, not always hardy, somewhat uncertain in bearing. Flowers semifertile. Cluster large, long to medium, inclined to slender, cylindrical to slightly tapering, often blunt, sometimes shouldered, medium to compact; peduncle long and slender. Berries above medium size, inclined to oval, attractive greenish yellow, rather glossy gray bloom, persistent, firm. Skin thin to medium, tough, adheres slightly to the pulp, contains no pigment, astringent. Flesh greenish white, somewhat translucent, juicy, tender and melting, aromatic, sweet from skin to center, quality excellent; one of the best. Ripens midseason. Excellent for table and market and a good juice grape. Suggested for districts 3, 5, 6, and 9.

Krause.—(Bourq., Lab., Vin.) Origin, Texas, 1893. Vine vigorous, slightly attacked by mildew in damp seasons. Flowers self-fertile. Cluster large, shouldered, medium to short, rather broad, cylindrical to slightly tapering, medium loose; peduncle medium in size and thickness. Berries large, globular, pearly white, handsome; skin thin, pulp tender, melting, of excellent quality. Ripens midseason. Sugar 14.1° Balling; acid 0.80. A valuable market and table grape for the South, and northerly to Kansas and Kentucky. Suggested for districts 5, 6, and 9.

Niagara.—(Lab., Vin.) Origin, New York, 1868. Vine vigorous to medium, not hardy in extremely cold winters, irregularly productive. Flowers self-fertile. Cluster large to medium, long to medium, somewhat broad, tapering to often cylindrical, often single-shouldered, moderately compact; peduncle short to medium, thick. Berries above medium to large, slightly oval, light green changing to yellowish-green tinge, gray bloom, persistent, firm. Skin thin, tender, adheres somewhat to pulp, contains no pigment, slightly astringent. Flesh light green, translucent, juicy, fine grained, moderately tender, foxy, sweet next to skin to agreeably tart at center. Fair in quality. Sugar 16.1° Balling; acid 0.61. Ripens midseason to late. A good all-purpose grape. Suggested for districts 2, 3, 4, 5, 6, 7, 8, 11, and 12.

Rommel.—(Lab., Rip., Vin.) Origin, Texas, 1885. Vine medium to vigorous, not always hardy, medium to productive. Flowers semifertile, stamens upright. Cluster variable in size, above medium to short, moderately broad, cylindrical to slightly tapering, usually single-shouldered, compact to medium; peduncle long to medium, thick. Berries large to medium, oblate to globular, frequently compressed on account of compactness of cluster, light green with yellow tinge, covered with gray bloom, persistent, firm, breaking easily under pressure. Skin thin, cracks badly, medium to tender, adheres to pulp, contains no pigment, without astringency. Flesh greenish, translucent, juicy, tender, and melting, slightly stringy, sweet to agreeably tart at center; variable in quality, but usually very good. Sugar 16.2° Balling; acid 0.97. Ripens in midseason; ships and keeps fairly well. A good all-purpose and excellent white-juice grape. Suggested for districts 3, 4, 6, and 9.

Wapanuka.—(Lab., Rip., Vin., Bourq.) Origin, Texas, 1893. Vine medium to strong, usually hardy, productive. Flowers fertile or nearly so. Cluster intermediate in size, long to medium, cylindrical, frequently with a long peduncle, single shoulder, compact. Berries large, globular, rich yellowish white, gray bloom, translucent, soft, with tendency to shatter. Skin covered with few small dark dots, very thin and tender. Flesh usually pale green, tender, somewhat foxy, sweet, and mild, seldom cracks, very good in quality. Ripens medium early to midseason. Sugar 14.5° Balling; acid 0.45. Excellent for table and near-by markets and a good juice grape. Suggested for districts 3, 4, 5, and 9.

Winchell.—(Lab., Vin., Aest.) Origin, Vermont, about 1860. Vine vigorous, hardy, healthy, very productive. Flowers fertile, stamens upright. Cluster large to below medium, long, slender, cylindrical to slightly tapering, often with a long single shoulder, loose to moderately compact; peduncle long, moderately slender. Berries above medium to small, globular, light green, thin white bloom, usually persistent, soft. Skin often marked with small reddish-brown spots, thin, tender, adheres slightly to pulp, contains no pigment, slightly astringent. Flesh greenish, translucent, juicy, tender, fine grained, sweet, very good to best in quality. Sugar 20.4° Balling; acid 0.66. The best all-purpose, very early white grape and an excellent juice grape. Suggested for districts 2, 3, 4, 6, 7, 8, 11, and 12.

RED VARIETIES

Agawam.—(Lab., Vin.) Origin, Massachusetts, about 1855. Vine vigorous, usually hardy, medium to productive. Flowers nearly self-fertile. Cluster variable, averaging medium to large, short, rather broad, tapering to somewhat cylindrical, sometimes single-shouldered, somewhat loose; peduncle medium to short, fairly thick. Berries fairly large, globular to slightly oval, dark and dull purplish red, covered with lilac bloom, very persistent. Skin tough, thick, adheres slightly to the pulp, contains very little pigment, somewhat astringent. Flesh pale green, translucent, tough, slightly stringy, rather solid, foxy, good in quality. Ripens medium to medium late. An excellent all-around grape. The qualities recommending it are its large size of bunch and berry, rich, sweet, aromatic flavor, attractive appearance, excellent shipping and keeping qualities. Sugar 18.1° Balling; acid 0.86. Suggested for districts 3, 4, 6, 8, and 12.

Brighton.—(Lab., Vin.) Origin, New York, about 1870. Vine vigorous, hardy, usually producing fair crops. Flowers sterile; stamens reflexed. Cluster very large to medium, usually long, broadish, tapering, often heavily shouldered, loose to compact; peduncle quite long. Berries irregular, medium to large in size, globular to slightly oval, light and dark red, somewhat glossy, dark lilac bloom, handsome, persistent, not firm. Skin thickish, very tender, adheres considerably to pulp, contains no pigment, astringent. Flesh greenish, very good in quality. Ripens early to midseason. Sugar 20.1° Balling; acid 0.68. Brighton is usually included in collections and ranks as one of the amateur northern grapes. Not being self-fertile, it should be interplanted with pollenizers. Suggested for districts 2, 3, 4, 6, 7, 11, and 12.

Brilliant.—(Lab., Vin., Bourq.) Origin, Texas, 1883. Vine variable in growth, averaging vigorous, hardy up to 15° F. below zero, usually productive. Flowers self-fertile. Cluster large, cylindrical, or somewhat conical, often shouldered, open to compact. Berries large, globular, light to dark red, translucent, glossy, with abundant lilac bloom, adheres strongly to pedicel, firm. Skin rather thin and tough, adheres considerably to pulp, contains no pigment, slightly astringent. Flesh pale green, rather translucent, juicy, slightly stringy, very tender, melting, and delicious. Ripens medium early to midseason. Sugar 18.7° Balling, acid 0.69. Endures heat and drought fairly well. Adapted to South and North. Hardy up to 34° N. latitude. Suggested for districts 3, 4, 6, and 7.

Captivator.—(Lab., Vin., Bourq.) Origin, Texas, 1902. Vine of good vigorous growth, usually productive. Flowers self-fertile. Clusters large, cylindrical, sometimes shouldered, properly compact. Berries persistent, large to very large, globular, clear, lively, translucent red; skin thin, tough; pulp tender, melting, sweet, and of delicious quality. Sugar 18.7° Balling; acid, 0.70. Ripens medium early to medium. A good all-purpose grape. Exceedingly attractive. Splendid for table and juice. Suggested for districts 5 and 9.

Catawba.—(Lab., Vin.) Origin, unknown. Introduced from Maryland into the District of Columbia by John Adlum about 1823. Vine vigorous to medium, hardy, productive. Flowers fertile. Cluster large to medium, rather long, usually broad, nearly cylindrical to tapering, single to sometimes double-shouldered, rather loose to compact; peduncle average length, rather slender. Berries intermediate in size, oval to globular, dull purplish red, with lilac bloom, persistent, firm. Skin rather thick, variable in toughness, slightly adheres to pulp, with no pigment, somewhat astringent. Flesh green, translucent, juicy, fine grained, slightly tough to soft. Sugar 19.8° Balling; acid 0.93. Ripens late. An excellent all-purpose grape and one of the most interesting American varieties. A good shipping and keeping and an excellent juice grape. Suggested for districts 3 and 6.

Delaware.—(Lab., Bourq., Vin.) Origin probably New Jersey about 1830. Vine not a strong grower, hardy except in unfavorable locations, productive. Flowers, self-fertile. Clusters medium to small, average length, slender, rather blunt, often cylindrical, regular, usually shouldered, compact; peduncle, medium to short, slender. Berries uniform in size and shape, small to medium, globular, light red, covered with lilac bloom, persistent, firm. Skin thin, moderately tough, adheres slightly to pulp, contains no pigment, slightly astringent. Flesh light green, translucent, juicy, tender, aromatic, vinous, sprightly, and refreshing, sweet to agreeably tart from skin to center, best in quality. Ripens medium early to midseason. Sugar 21.3° Balling; acid, 0.73. Delaware is of choicest quality and next to Concord is the most popular grape for garden and vineyard grown in the United States. Suggested for districts 2, 3, 4, 6, 7, 8, 9, 11, and 12.

Ellen Scott.—(Linc., Lab., Vin.) Origin, Texas, 1902. Vine hardy from latitude 34° to 38° N. and longitude 98° E.; stocky, vigorous, productive. Flowers self-fertile. Cluster very large, conical, often shouldered; peduncle short. Berry very persistent, globular, medium to large, dark, translucent, violet. Skin thin but does not crack, delicate. Flesh breaking, melting, of most sprightly delicious character. Sugar 18.7° Balling; acid 0.95. Ripens late. A very handsome table and market grape; should also make a very good juice. Suggested for districts 5 and 9.

Goethe.—(Lab., Vin.) Origin, Massachusetts, about 1855. Vine of medium vigor, hardy, variable in productiveness. Flowers partly fertile. Cluster intermediate in size, short to medium, rather broad, widely tapering, often single-shouldered, intermediate in compactness; peduncle rather short, of average thickness. Berries very large to above medium, oval to nearly globular, pale red, with thin gray or slightly lilac bloom, rather firm, persistent. Skin thin, tender to medium, adheres slightly to the pulp, contains no pigment, faintly astringent. Flesh pale green, translucent, inclined to tenderness, rather coarse, nearly sweet at skin but decidedly tart at center, with some vinifera sprightliness. Of very good quality in many northern localities. Sugar 17.4° Balling;

acid 1.13. A splendid table and market grape. Keeps well and is excellent for juice. Suggested for districts 3 and 6.

Goff.—(Lab., Vin., Aest.) Origin, New York, about 1890. Vine vigorous, hardy, productive. Flowers self-fertile. Clusters variable in size, long to medium, frequently very slender, cylindrical surface, often irregular with a blunt end larger than the part above, sometimes shouldered with a small single shoulder, compact; peduncle usually short, intermediate in thickness. Berries variable in size, medium to above medium, often misshapen, strongly flattened, not uniform, dark reddish purple, with lilac bloom, firm, persistent. Skin thick, medium tough, adheres slightly to pulp, pigment bright red, slightly astringent. Flesh pale green, translucent, juicy, tender, a little coarse, somewhat vinous, sweet from skin to center, good in quality. Sugar 16° Balling; acid 0.61. Ripens late. An excellent keeper, good all-purpose grape. Suggested for districts 2, 3, 6, 7, 8, and 11.

Headlight.—(Vin., Lab., Bourq.) Origin, Texas, 1895. Vine of medium vigor, hardy, very productive. Flowers sterile, stamens reflexed. Clusters small to medium, average breadth, very compact, shouldered, tapering; peduncle short to medium, slender. Berries medium to above medium, globular, clear, dark red with light-blue bloom, firm, persistent. Skin thin, tough, adheres to the pulp, contains some light-red pigment, astringent. Flesh greenish, translucent, juicy, fine grained, vinous, sweet; quality very good. Sugar 16.6° Balling; acid 0.45. Ripens very early. Valuable as an extra-early market and table grape, of high quality and good keeper. Suggested for district 4.

Last Rose.—(Linc., Vin., Lab.) Origin, Texas. Vine vigorous, healthy, productive. Clusters very large, compact, long, conical with heavy shoulder. Berries medium to large, dark shiny red, round. Pulp tender, of very good quality. Ripening very late. A very handsome market grape. Suggested for districts 4, 5, and 9.

Lucile.—(Lab.) Origin, New York, 1888. Vine vigorous, hardy, very productive. Flowers self-fertile. Clusters medium to above medium, rather long and slender, cylindrical to tapering, often single-shouldered, very compact; peduncle large, intermediate in length. Berries large to medium, globular to slightly oval when decidedly compacted, dark dull red, with lilac bloom, firm, persistent. Skin medium to thin, somewhat tender, contains some light-red pigment and some astringency. Flesh pale green, translucent, juicy, rather tough, sometimes stringy, foxy, sweet next to the skin to slightly tart at center, fair to good in quality. Fruit ripens medium early. Sugar 15.5° Balling; acid 0.83. Fruit keeps well. Although of not more than medium quality, this variety can be recommended for its superior hardiness, good productiveness, and thriftiness in all good grape soils. Suggested for districts 2, 3, 4, 6, 7, and 8.

Valhallah.—(Lab., Cand., Rip., Vin., Bourq.) Origin, Texas, about 1902. Vine vigorous, drought resisting, prolific. Flowers self-fertile. Cluster medium size, shouldered. Berries large, dark, translucent red, globular, skin thin, tough; pulp juicy, tender, of very good quality. Ripens medium late to late. Sugar 16.5° Balling; acid 0.85. Keeps well on the vine. Adapted on Gulf plains 100 miles wide and in western Texas, New Mexico, and Oklahoma. Useful for table, market, and juice. Suggested for districts 5 and 9.

Vergennes.—(Lab.) Origin, Vermont, about 1870. Vine variable in vigor, not always hardy, medium to very productive, depending upon amount of winter injury, usually healthy. Flowers nearly sterile. Clusters intermediate in size and length, broad, cylindrical to tapering, occasionally single-shouldered, inclined to be loose; peduncle short to medium, thick. Berries large to below medium, oval to globular, light and dark red, lilac bloom, firm, persistent. Skin does not crack, thick, tough, adheres considerably to the pulp, contains no pigment, astringent. Flesh pale green, juicy, fine grained, somewhat stringy, tender, vinous, sweet next to the skin, agreeably tart at center, good to very good in quality. Keeps and ships well. Ripens late to medium late. Sugar 17.8° Balling; acid 0.74. Recommended for its intrinsic value, late ripening, and regular bearing. Suggested for districts 2, 6, 7, and 8.

BLACK VARIETIES

Alpha.—(Rip. ×.) Origin, Minnesota; found wild in 1901. Vine vigorous and prolific, very hardy and resistant to mildew. Cluster large, rather long, cylindrically tapering. Berries medium to below medium in size, globular, bluish black, fairly sweet, vinous. Ripens early. Good for preserves, jelly, and native juice for family use. Suggested for district 1.

Bailey.—(Linc., Lab., Vin.) Origin, Texas, 1887. Vine vigorous, not always hardy, productive. Flowers self-fertile. Clusters rather large, long, not broad, often blunt at ends, cylindrical to irregularly tapering, sometimes small, short-shouldered, compact. Berries persistent, medium to large, globular to ovate on account of compactness; color purplish black to black, heavy blue bloom. Skin medium thin, astringent, tough, adheres somewhat to pulp; pigment purplish red. Flesh moderately juicy and tender, coarse, vinous, of good quality, seeds parting readily. Ripens late. Sugar 19.04° Balling; acid 0.89. Good for local markets and for juice purposes. Suggested for districts 5 and 9.

Beacon.—(Linc., Lab.) Origin, Texas, 1887. Vine vigorous, not always hardy, very productive. Flowers nearly self-fertile. Clusters attractive, good size, rather long, medium to slightly slender, cylindrical to somewhat tapering, usually single-shouldered, compact. Berries medium but variable in size, globular, purplish black to black, dull in appearance, blue bloom, inclined to shell in some localities, moderately firm. Skin medium to thin, tough, adheres strongly to pulp; pigment purplish red, astringent. Flesh moderately tender, slightly aromatic, spicy, vinous, mildly subacid to agreeably tart. Ripens medium late. Sugar 17° Balling; acid 1.05. A good all-purpose grape. Suggested for districts 5 and 9.

Beta.—(Lab., Rip.) Origin, Minnesota. Vine vigorous, very hardy, and productive. Flowers self-fertile. Cluster small to medium size, compact, cylindrical, often shouldered. Berries medium to below medium in size, globular, black, light blue bloom, fairly sweet, vinous. Ripens early. Sugar 17° Balling; acid 1.17. Good for preserves, jelly, and juice. Suggested for district 1.

Campbell Early.—(Lab., Vin.) Origin, Ohio, about 1888. Vine fairly vigorous, hardy, productive, but rather sensitive as to soils. Flowers self-fertile. Clusters range from medium to large in size, rather long and broad, tapering to cylindrical, often single-shouldered, compact to slightly loose. Berries somewhat variable in size, usually large, globular to slightly oval, dark purplish black, rather dull as the season advances, heavy blue bloom, firm, persistent. Skin medium to thin, tough, does not crack, adheres slightly to pulp, contains small amount of dark-red pigment, astringent. Flesh greenish, translucent, juicy, varying from rather tough to nearly soft, slightly coarse, not foxy, somewhat vinous, nearly sweet from skin to tart at center; quality good. Ripens medium early and fruit keeps well on the vines. Sugar 17.2° Balling; acid 0.79. Of good shipping and keeping qualities. Suggested for districts 2, 3, 6, and 7.

Carman.—(Linc., Vin., Lab.) Origin, Texas, about 1888. Vine usually vigorous, hardy, varies in productiveness. Flowers fertile or nearly so. Clusters variable in size, of average length and breadth, tapering to cylindrical, often single-shouldered, usually compact; peduncle above medium length and thickness. Berries inferior in size, globular to slightly oblate, dark purplish black to black, glossy, blue bloom, firm, persistent. Skin rather thin, tough, nearly free from pulp, contains little or no pigment, not astringent. Flesh yellowish green, not juicy, somewhat tender when fully ripe, has some post-oak flavor, vinous, spicy, sweetish at skin to tart next the seeds, quality good. Sugar 17.3° Balling; acid 0.45. Ripens late, keeps well on vines and after harvesting. Too late for most northern locations. Well regarded in many sections of the South to as far north as latitude 40° N. Suggested for districts 3, 4, 5, and 9.

Cloeta.—(Linc., Rup., Lab., Vin.) Origin, Texas, about 1885. Vine very vigorous, hardy, fairly to very productive. Flowers self-fertile. Cluster large, long, cylindrical, frequently single-shouldered, intermediate in compactness. Berries medium to large, globular, black, blue bloom, persistent, firm. Skin thin, handles well; pulp tender, juicy, sprightly flavor; quality good. Ripens late. Sugar 14° Balling; acid 1.08. Used for market, table, and red juice. Requires hot, dry weather to acquire high quality. Adapted to Gulf plains 100 miles wide, western Texas, New Mexico, Oklahoma, Kansas, Nebraska. Suggested for districts 5 and 9.

Concord.—(Lab.) Origin, Massachusetts, 1843. Vine vigorous to very vigorous, hardy, healthy, usually productive of heavy crops. Although it succeeds on a great variety of soils, it really requires rich soil and thrives best on virgin soils. Flowers self-fertile. Cluster rather uniform, medium to large, intermediate in length, wide and broadly tapering, usually single-shouldered, sometimes double-shouldered, medium to rather compact; peduncle short to medium thick. Berries medium to large globular, slightly glossy, black, abundant blue bloom, not always persistent, firm. Skin average thickness, moderately tough, slightly adherent to pulp, contains a small amount of wine-colored pigment, somewhat astringent. Flesh pale green, translucent, juicy, rather fine grained, somewhat tough and solid, slightly foxy, sweet at skin, inclined to tartness next the seeds, good in quality. Sugar 17.9° Balling; acid 0.94. Ripens medium late. Widely used as juice grape. The most widely grown grape of this continent, due to its ability to adapt itself to different conditions and to withstand insects and diseases, its fruitfulness, hardiness, comparative earliness, which insures its maturing in northern sections, the fair size of its bunch and berry, and its attractive cluster. Among its faults are: Mediocrity in quality; lack of richness, delicacy of flavor, and aroma; great foxiness, objectionable to many; large and abundant seeds that are difficult to separate from the flesh; tough, astringent skin, inclined to crack; berries inclined to shell from stem after picking; rapid loss of flavor after ripening; does not ship and keep as well as many other varieties; and being essentially a northern grape, when grown in the South becomes susceptible to fungi and ripens unevenly. Suggested for districts 2, 3, 6, 7, and 8.

Cynthiana.—(Aest. × Lab.) Origin, Arkansas, about 1850. Vine vigorous, healthy, hardy to latitude 41° N., usually a good yielder. It prefers sandy or gravelly loams and does not thrive on clay or limestone soils. Clusters medium to small, rather long, intermediate in breadth, tapering to cylindrical; not very uniform, often single-shouldered, compact; peduncle above medium length, small. Berries small, globular, black, blue bloom, persistent, firm. Skin thin, tough, rather adherent to pulp, pigment purple, astringent. Flesh dark green, translucent, juicy, tough and solid, spicy, rather tart; not a dessert grape, but excellent in quality for red juice. Sugar 22.8° Balling; acid 1.40. Ripens late. The juice is perhaps the best of all red juices produced from American grapes. Suggested for districts 3, 4, and 6.

Dakota.—(Lab., Rip.) Origin, Minnesota. A good eve grower, hardy, productive. Cluster medium in size, compact, cylindrical, often shouldered. Berries averaging medium size, globular, black, blue bloom, fairly sweet, good quality. Sugar 11.3° Balling; acid 1.45. Ripens early. Good for preserves, jelly, and juice. Suggested for district 1.

Fern Munson.—(Linc., Vin., Lab.) Origin, Texas, 1885. Vine vigorous, not hardy north of latitude 40° N., productive. Flowers semifertile, clusters medium to large, not very long, variable in width, irregularly tapering, rather cylindrical, usually single-shouldered, variable in compactness, with occasionally abortive fruits. Berries medium to large, globular to slightly flattened, dark purplish black, rather glossy, thin blue bloom, strongly persistent, firm. Skin thin, tough, wine-colored pigment, rather astringent. Flesh juicy, tough, and solid, becoming tender on maturity, fine grained, vinous, briskly subacid to acid, of good quality when thoroughly ripened. Sugar 18.5° Balling; acid 0.90. Ripens quite late. Has endured 27° F. below zero, and resists drought remarkably well. Suggested for districts 4, 6, and 8.

Herbemont.—(Bourq.) Origin, unknown. Vine vigorous to very vigorous, productive. Flowers self-fertile. Clusters large, long, tapering to cylindrical, prominently shouldered, compact, peduncle long and strong. Berries globular, below medium in size, uniform, reddish black, blue bloom. Skin thin, tough, with considerable pigment. Flesh tender, very juicy, rather sweet, sprightly to slightly acid, very good in quality. Ripens late. A good local-market and juice grape. Sugar 19.9° Balling; acid 1.00. Suggested for districts 4, 5, and 9.

Hernito.—(Lab., Vin.) Origin, Texas, 1900. Vine vigorous, liable to injury in the North in severe winters; productive. Flowers nearly self-fertile. Cluster medium to large, rather short, broad, fairly compact, occasionally shouldered; peduncle medium to short. Berries uneven in size, averaging above medium, globular to oblate, mostly oblate, moderately firm, persistent. Skin medium thick, tough, purplish black, blue bloom; pigment wine colored, astringent. Flesh dark green, separating from the seeds fairly easily, but rather tough; pulp moderately juicy, sprightly, mildly subacid, pleasing. Sugar 14° Balling; acid 0.75. Ripens late. One of the best varieties for storing after maturity, keeping well in both cellar and cold storage. A good all-purpose grape. Suggested for districts 3, 4, 6, and 7.

Hubbard.—(Lab., Vin.) Origin, Arkansas about 1908. Vine medium to vigorous, hardy up to latitude 42° N., very productive. Flowers self-fertile. Clusters medium to above medium in size, average 6 inches long and 4 inches broad, regularly tapering, fairly compact; peduncle about seven-eighths of an inch long, medium size. Berries above medium to large, globular, dark purplish black, blue bloom, persistent, firm. Skin thin, tough, pigment wine colored, astringent. Flesh light green, medium firm, juicy, translucent, tender, fine grained, fruity, rich, vinous; quality very good. Sugar 14° Balling; acid 0.85. Ripens medium early; appears to shell badly after picking, and for this reason it has not taken better with the trade. Suggested for districts 3, 4, and 6.

Hungarian.—Origin, Minnesota, about 1900. Vine vigorous, very productive. Cluster fairly large, compact, cylindrical. Berries black, medium size, sweet, pleasant flavor, good quality. Ripens very early. Although not so hardy as some of the other varieties it is considered promising for extreme northern conditions. Good for household uses and juice. Suggested for district 1.

Husmann.—(Linc., Vin., Lab.) Origin, Texas, 1892. Vine vigorous, prolific, successful on the Gulf plain and north to latitude 34° N. Flowers self-fertile. Cluster very large, long, cylindrical, sometimes shouldered, compact; peduncle medium. Berries medium size, globular, black, persistent. Skin thin, delicate yet tough, pigment wine colored; pulp melting, very juicy, sprightly, of high, pure flavor. Sugar 20° Balling; acid 0.81. Ripens medium late. A good market and table and an excellent red-juice grape. Suggested for districts 3, 6, and 9.

Isabella.—(Lab., Vin.) Origin, probably one of the Carolinas about 1800. Vine vigorous, usually hardy, variable in productiveness. Flowers self-fertile. Clusters large to medium, intermediate in length, nearly cylindrical to conical, often single-shouldered, variable in compactness; peduncle short to medium, thick. Berries variable in size, medium to large, oval, deep-black color long before ripe, blue bloom, usually persistent, soft. Skin thick to medium, very tough, adheres considerably to the pulp, astringent. Flesh pale green, sometimes with yellowish tinge, translucent, juicy, fine grained, tender but meaty, somewhat stringy, inclined to foxiness, sweet to agreeably tart at center, slightly astringent when not mature, good in quality. Sugar 14.5° Balling; acid 0.71. Ripens late. In the early days of grape growing it was the grape of the North and the New England States. Suggested for districts 7, 8, 11, and 12.

Ives.—(Lab., Aest.) Origin, Ohio, 1840. Vine vigorous, hardy, healthy, productive to very productive. Flowers self-fertile. Cluster fair sized, of medium length and breadth, tapering to nearly cylindrical, frequently single-shouldered, compact to medium, often with numerous abortive berries; peduncle long to medium, of average thickness. Berries intermediate in size, oval to globular, jet black, blue bloom, very persistent, firm. Skin medium thick, tough, adheres slightly to the pulp; pigment wine colored, slightly astringent. Flesh pale green, translucent, juicy, fine grained, very tough, foxy, sweet at skin to tart at center, hardly good in quality. Ripens medium late. Sugar 18° Balling; acid 0.81. Its chief recommendations are good bearing qualities and that it makes a good red juice. Suggested for districts 2, 3, 6, 7, and 8.

Janesville.—(Lab., Rip.) Origin, Wisconsin, 1858. Vine vigorous, healthy, very hardy, productive. Flowers self-fertile. Clusters medium to small, short, of average breadth, cylindrical to tapering, usually single-shouldered, compact; peduncle short, slender. Berries intermediate in size, globular to slightly oval, dull black, blue bloom, usually persistent, firm. Skin thick, fairly tough, adheres slightly to the pulp, pigment dark wine color, astringent. Flesh pale reddish green, translucent, juicy, very tough, rather coarse, vinous, sweet next the skin and at center, fair in quality. Ripens very early. Should be grown only in northern localities where better grapes can not be grown, or where fruit for a cheap red juice is wanted. Suggested for district 1.

Lenoir.—(Bourq.) Origin, probably one of the Carolinas or Georgia in the eighteenth century. Vine vigorous, thrifty, usually quite productive. This is a southern grape, too tender and too late in ripening for even the Middle States. Self-fertile. Clusters vary from medium size to very large, tapering, usually shouldered. Berries small to medium, globular, of a dark bluish purple, nearly black, with lilac bloom. Skin rather thick, tough. Flesh slightly juicy, tender, subacidly sweet, very rich in coloring matter. Sugar 23° Balling; acid 1.50. Ripens rather late. This variety flourishes and bears large crops in many places along the Gulf coast. It makes a good, exceedingly dark, intensely colored red juice, because of which it has been largely used in blending. Suggested for districts 3, 4, and 8.

Moore Early.—(Lab.) Origin, Massachusetts, about 1865. Vine medium to vigorous, hardy, not a heavy yielder. Flowers self-fertile. Cluster intermediate in size, length and breadth irregularly cylindrical to tapering, often single-shouldered, inclined to looseness; peduncle short to medium, thick. Berries above medium to large, globular, dark purplish-black blue bloom, not very persistent, fairly firm, cracks under unfavorable conditions. Skin medium thick, tender, with tendency to adhere to the pulp; pigment dark purplish red, not astringent. Flesh greenish, translucent, juicy, fine grained, tough, with slight foxiness, sweet next the skin, somewhat tart at center, fair to good in quality; is satisfactory only on rich soils and with good culture and care. Sugar 16.9° Balling; acid 1.18. While not an ideal grape, it ripens early and probably will be planted until a better early grape is found. Suggested for districts 2, 3, 4, 6, 7, and 8.

Norton.—(Aest., Lab.) Origin, probably Virginia, about 1825. Vine very vigorous, healthy, uncertain, but usually good bearer, not considered fully hardy in States east of the Rocky Mountains and north of about latitude 40° N. Flowers self-fertile. Clusters medium to small, rather short, moderately broad, tapering, usually single-shouldered, medium to compact; peduncle short to medium, thick, sometimes flattened. Berries medium to small, globular to oblate, black, somewhat glossy, blue bloom, persistent, soft. Skin thin, of average toughness, does not adhere to the pulp, pigment dark red, no astringency. Flesh greenish translucent, juicy, tender, spicy, tart, somewhat astringent. Ripens late. Requires a long warm season to reach maturity. It has great adaptability to soils and thrives in rich alluvials, or in clays, gravels, or sandy soils that are fairly fertile and warm. Excepting perhaps Cynthiana, the Norton is the leading red-juice grape of the eastern United States. Sugar 23.7° Balling; acid 1.32. It makes a juice of highest quality and is of small value for other purposes. Suggested for districts 3 and 4.

Manito.—(Lab., Vin., Bourq., Linc., Rup.) Origin, Texas, 1895. Vine medium to vigorous, hardy, medium to productive. Flowers semifertile. Clusters long, cylindrical, rather open, sometimes with enlarged end, usually not shouldered; peduncle intermediate in length, slender. Berries medium, globular, persistent, dark purple with white specks, very distinct and unique in appearance. Skin thin, tender, adheres considerably to pulp, wine-colored pigment, astringent. Flesh pale green, with slight pink tinge, translucent, moderately juicy, tender, almost melting, not very aromatic, parts readily from the seeds, sweet next to skin to agreeably tart at center, good in quality. Sugar 13.6° Balling; acid 0.72. Ripens very early. Packs and ships well. A profitable market and good juice grape. Suggested for districts 3, 4, and 9.

Monitor.—Origin, Minnesota. Vine good grower, hardy, productive. Cluster small to medium size, compact, cylindrical, nearly round. Berries medium to below in size, globular, fair in quality. Ripens very early. Good for household use and juice. Suggested for district 1.

Suelter.—(Lab., Rip.) Origin, Minnesota. Good, strong grower, very productive and hardy. Flowers not fully self-fertile. Clusters of good size, compact, cylindrical, tapering, often single-shouldered, sometimes double-shouldered. Berries medium to above medium in size, black, globular, and of good quality. Sugar 17.5° Balling; acid 0.85. Suggested for district 1.

Worden.—(Lab.) Origin, New York, 1863. Vine vigorous, hardy, productive, healthy. Flowers self-fertile. Clusters large, medium to long, broad-tapering to cylindrical, usually single-shouldered, somewhat compact; peduncle short, thick. Berries large, roundish to oval, dark purplish black to black, glossy, covered with heavy blue bloom, not always persistent, moderately firm. Skin of average thickness, somewhat tender, cracks badly, adheres slightly to the pulp, contains considerable dark-red pigment, astringent. Flesh greenish, translucent, juicy, fine grained, tough, slightly foxy, sweet at skin to tart at center, mild, good to very good in quality. Sugar 16.2° Balling; acid 1.06. Ripens midseason from a week to 10 days earlier than Concord, has larger berries and bunches, and is of better quality. Its chief fault is that the fruit cracks badly, often preventing profitable marketing. It does not keep or ship as well as Concord. Suggested for districts 2, 3, 4, 6, 7, 8, 11, and 12.

MUSCADINE TYPE

All the catalogued and commercially grown muscadine varieties are pistillate or female-flowered and incapable of self-fertilization. Furthermore, because they bloom much later than the euvitis varieties, they should be interplanted with male or staminate rotundifolia as pollinizers. As these have an abundance of virile pollen, one such staminate vine is sufficient to pollinate at least 10 self-sterile vines. Brief descriptions of the leading commercial rotundifolia varieties follow:[4]

WHITE VARIETY

Scuppernong.—(Rot.) Origin, North Carolina. Vine a vigorous, rank grower, productive. Flowers not self-fertile, pistillate. Cluster small, having 1 to 15 berries, but generally 2 to 16 berries. Berries, globular, averaging three-fourths inch in diameter: pearly green to reddish brown in color, individual berries shatter, firm. Skin medium thick, tough, covered with small russet dots and sometimes russet blotches. Flesh pale green, juicy, soft, musky, sweet, sprightly, of good quality. Sugar 15.88° Balling; acid 0.89. Ripens midseason. The most extensively grown of all the muscadine varieties. Suitable for local markets, home use, and juice. Suggested for districts 4 and 5.

BLACK VARIETIES

Eden.—(Rot., Mun.) Origin, Georgia. Vine vigorous and productive. Flowers not self-fertile, pistillate. Cluster loose, containing from 5 to 25 berries. Berries globular, about one-half inch in diameter, dull black when fully ripe, faintly speckled, and adheres fairly well to the pedicel. Flesh soft, juicy, colorless, with pleasant sprightly flavor, quality very good. Skin relatively thin and tender. Sugar 11.78° Balling; acid 1.07. It is well adapted for juice, home, and kitchen use. Suggested for districts 4 and 5.

Flowers.—(Rot.) Origin, North Carolina. Vine an upright, slender, open, moderately robust grower, productive. Flowers not self-fertile, pistillate. Cluster globular, containing generally from 6 to 10 medium-sized, purplish black, slightly oval berries. Skin very thick, tough, and faintly marked with dots. Flesh white, meaty, tough, not very juicy. Flavor is sweetish, lacks sprightliness, and is of medium quality. Sugar 14.42° Balling; acid 0.65. Adapted for juice, home, and kitchen use. Suggested for districts 4 and 5.

James.—(Rot.) Origin. North Carolina. Vine a vigorous, slightly trailing grower, productive. Flowers not self-fertile, pistillate. Cluster globular, containing from 2 to 12, sometimes more, but usually from 4 to 6, large, globular, rather glossy, bluish or dark purplish-black berries when fully ripe, with pronounced but not very numerous "guinea egg" specks. The variety is rather late in ripening, and when not fully ripe there is a characteristic reddish coloring around the pedicel. Berry is juicy and flesh meaty. Skin thick, rather tough, flavor and quality medium. Sugar 13.88° Balling; acid 0.62. The all-purpose grape among the muscadines. Suggested for districts 4 and 5.

Mish.—(Rot.) Origin. North Carolina. Vine a rather vigorous, open, slightly trailing grower, productive. Flowers not self-fertile, pistillate. Cluster of medium size, berries adhering fairly well to pedicel. Berries range from eleven-sixteenths to three-fourths inch in diameter, are slightly ovoid, almost black, and have numerous "guinea egg" specks. The variety ripens uniformly but late. Skin medium thin, cracking in wet weather. Flesh is tender, juicy, and sweet. Flavor is distinct, delicious, and of fine quality. Sugar 16.77° Balling; acid 0.48. The Mish is the best all-round muscadine, and is esteemed next to the Scuppernong as a juice grape. Suggested for districts 4 and 5.

Thomas.—(Rot.) Origin, South Carolina. Vine a vigorous, rank grower and very productive. Flowers not self-fertile, pistillate. Cluster round and small. Berries are of medium size, globular, and when fully ripe of dark-wine color, the base surrounded by a wide, prominent, irregular greenish-yellow pentagonal marking. The berries ripen unevenly and have poor adherence to the pedicel. The flesh is tender, juicy, very sweet, and has an exceptionally rich, fruity, sprightly flavor. Sugar 16.58° Balling; acid 0.49. The skin is thin and moderately tough. with numerous pimples dotting the surface. Suggested for districts 4 and 5.

---

[4] Abbreviations used for species of Vitis are: Rot., *rotundifolia;* Mun., *munsoniana.*

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	ARTHUR M. HYDE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel and Business Administration.	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Solicitor	E. L. MARSHALL.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	R. Y. STUART, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Plant Quarantine and Control Administration	LEE A. STRONG, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*

U. S. GOVERNMENT PRINTING OFFICE: 1932

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1690

PLOWING WITH MOLDBOARD PLOWS

1862 1889

FOUR IMPORTANT factors in good plowing are: (1) Plow bottoms suited to the soil; (2) attachments suited to the work; (3) correct adjustments; (4) careful operation.

Proper adjustment of the plow hitch for depth and width of cut is especially important because it distributes side draft, saves power, and improves the quality of the work. When a few simple principles are understood the hitch adjustments can be made quickly and easily.

Plowshares should be kept properly pointed, and shares and moldboards protected from rust.

Clean plowing requires the use of properly adjusted covering attachments. Large rolling colters, jointers, and covering wires give good results under most conditions.

When buying a new moldboard plow, consider its ability to plow cleanly. Ample clearance for trash to pass between the plow bottoms, and plenty of working space for attachments, are desirable.

Washington, D. C. **Issued June, 1932**

PLOWING WITH MOLDBOARD PLOWS[1]

By Wallace Ashby, *Chief, Division of Structures*, and A. H. Glaves, *Junior Agricultural Engineer, Division of Mechanical Equipment, Bureau of Agricultural Engineering*

CONTENTS

Page
Plowing equipment 1
  Horse plows 1
  Tractor plows 2
  Two-way plows 2
  Plow bottoms 3
  Accessories for clean plowing 3
Getting ready for the field 6
  Plowshares 6
  Fitting and setting the attachments 8
Field adjustments 12
  Horse plows 12
  Tractor plows 14
Field practices 18
  Laying out fields 18
  Plowing speeds 18
Clean plowing 19
  Choice of equipment 19
  Covering attachments 19
  Practices that promote clean plowing 21
  Precautions to be taken after plowing 22

PLOWING USES more power than any other farm operation and often determines the size of tractor or number of horses that must be kept. Clean plowing, as illustrated in Figure 1, has proved to be one of the most effective ways of controlling the European corn borer and certain other insects which find winter shelter in crop refuse left in the field. It is also an aid in controlling weeds and certain plant diseases.

Plows must be properly adjusted and in good condition or they waste power and do not do first-class work. The purpose of this bulletin is to present information which will aid in keeping moldboard plows in good working order, in using them most effectively, and in selecting new equipment to replace old.

PLOWING EQUIPMENT

HORSE PLOWS

Horse-drawn plows are usually classified as walking, sulky, and gang plows. Sulkies and gangs may be either frameless (low lift) or framed (high lift). For a small acreage the walking plow is usually chosen. If considerable plowing is to be done a somewhat greater investment is warranted and the sulky or gang plow may be more suitable. Where ease of operation is important the framed or high-lift plow is often preferred to the low-lift type. Ordinarily there is little difference in draft between walking and wheeled plows of the same size, since the advantage of carrying the load on wheels is offset by the greater weight of the wheeled plow and the weight of the operator.

---

[1] This bulletin is based on experimental studies of plowing made jointly by the Bureau of Agricultural Engineering and the Plant Quarantine and Control Administration, in cooperation with the Bureau of Entomology. Use has been made of much information obtained from manufacturers and State agricultural experiment stations.

TRACTOR PLOWS

Three types of tractor-drawn moldboard plows are in common use, namely, 3-wheeled, 2-wheeled, and wheelless. Three-wheeled plows are usually built for heavy duty in 2-bottom, 3-bottom, or 4-bottom sizes, or larger. The weight is carried on all three wheels, both when at work and when the bottoms are lifted. In the 2-wheeled plows all the weight is carried on two wheels when the bottoms are lifted, though some of these plows are equipped with a fixed rear wheel, or rolling landside, which carries the land-side pressure when plowing. They are mostly lightweight, 1 or 2 bottom plows. Some plows of this type have ample clearance between the bottoms, but in others the beams have been shortened and clearance sacrificed to reduce the weight.

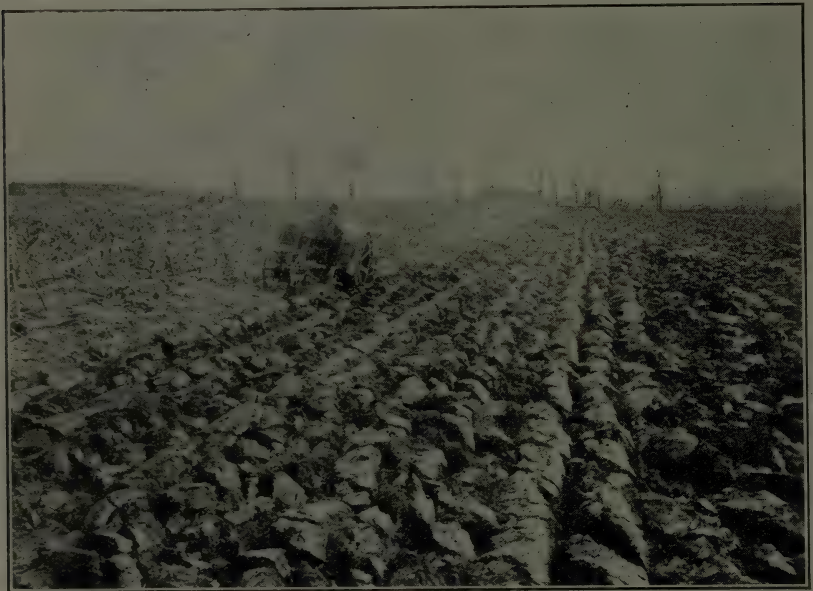


FIGURE 1.—Cornstalks plowed under cleanly. The soil is heavy clay loam; clean plowing is easier on lighter soils

A wheelless plow is mounted directly on the tractor, the drive-wheels of which serve instead of the usual plow wheels to steady the plow and to assist in regulating the depth. Both hand and power lift types are available. While wheelless tractor plows have been in use for several years, they have not been adopted so generally as might have been expected considering their light weight and ability to work in close quarters. This may be because they are not readily adapted to different makes of tractors and they are not so easily hitched and unhitched as the wheeled type of plow.

TWO-WAY PLOWS

Two-way plows,[2] for use on hillsides and under conditions where dead furrows must be avoided, as in irrigated fields, are made for either horse or tractor power. The bottom of a 2-way walking plow is hinged to the beam and may be set to turn the soil either to the right or to the left. Other 2-way plows for use with horses or tractor have right and left hand bottoms which are used alternately to throw all furrow slices in one direction. Most of these are wheeled plows, but some for use with tractors are similar to the wheelless plows described above.

---

[2] Directions for adjusting 2-way plows are given in Department Circular 132, Fighting the Corn Borer with Machinery in the Two-Generation Area.

PLOW BOTTOMS

A great variety of bottoms is available for different soil conditions and types of work. At one extreme is the breaker bottom for turning stiff sod. It is long and low, with a gradual turn that inverts sod without breaking it. At the other extreme is the stubble bottom with a rather high, abrupt moldboard which turns the furrow slice quickly to crumble it. Between these two are a great variety of general-purpose bottoms and a number of special-purpose bottoms to meet corresponding variations in plowing conditions. Plows for stiff soils and tame sods resemble the sod type, while plows for lighter soils approach the stubble type. This bulletin deals particularly with the general-purpose and stubble types of moldboard plows.

Good plowing requires a bottom suited to the soil and to the particular work to be done. It must scour, turn well-laid furrow slices, leave the soil in good condition to make a seed bed, cover trash thoroughly, resist wear, and have minimum draft. Usually a type of bottom that has been in use in a locality for some time will be found to meet most of these requirements. Until a new type of plow bottom has proved its worth in a locality it should be purchased only after trial, preferably on the farm where it is to be used. Since large plow bottoms cover trash better than small ones, and abundant power is furnished by tractors or by several horses in tandem team hitches, there is a tendency in some sections to use bottoms 16 inches or more in width. These are often referred to as " big-base " plows and are designed to turn under heavy growths of green-manure crops, stalks, and trash. Some of these plows are well adapted for such use and leave ordinary mellow soil in good condition to be worked into a seed bed. Large plow bottoms do not turn hard, dry soil so smoothly as do small bottoms, but this is not an objection when the land is being plowed in the fall for spring seeding.

Where soil conditions on a farm differ widely, or where different crops are to be plowed under—for example, cornstalks in one field and heavy sod in another—it may pay to have two sets of bottoms for the plow. Most manufacturers can furnish several types which can be interchanged by removing a few bolts.

ACCESSORIES FOR CLEAN PLOWING

A plow without attachments may turn over clean stubble land quite satisfactorily; but sod land, weedy land, or land on which there is a covering of straw, manure, cornstalks, or the like, may be plowed better if the plow is equipped with certain attachments. These should be selected to suit the work and to fit the plow. The attachments shown in Figure 2 are suitable for plowing under cornstalks or a heavy cover crop such as sweetclover. Since these attachments require space in which to do their work, plows for clean plowing should have ample clearance under the beams, braces, and axles. In gang plows there should be sufficient space between the moldboard of one bottom and the upright part of the beam ahead to allow the furrow slice and trash to pass without clogging. The more clearance at this point the better.

COLTERS

Rolling colters are used to cut roots and surface trash which might otherwise cause ragged furrows or clog the plow. They improve the work in most cases and often reduce the draft, but are not entirely satisfactory in soils containing loose stones. Colters as small as 12 inches in diameter may be satisfactory in plowing sod, but are ineffective when used in coarse or loose trash. A blade at least 15 inches in diameter is desirable if the plow has room to accommodate it, because large colters do better work and wear longer in proportion to their cost than do smaller ones. In heavy trash a 17 or 18 inch blade is best because it may be set reasonably deep and still mount and cut trash which a smaller blade would push ahead until clogging occurred. Roller bearings maintain proper alignment of the blade with less attention than is required for the cheaper types of bearings. Directions for setting the rolling colter are given on page 8.

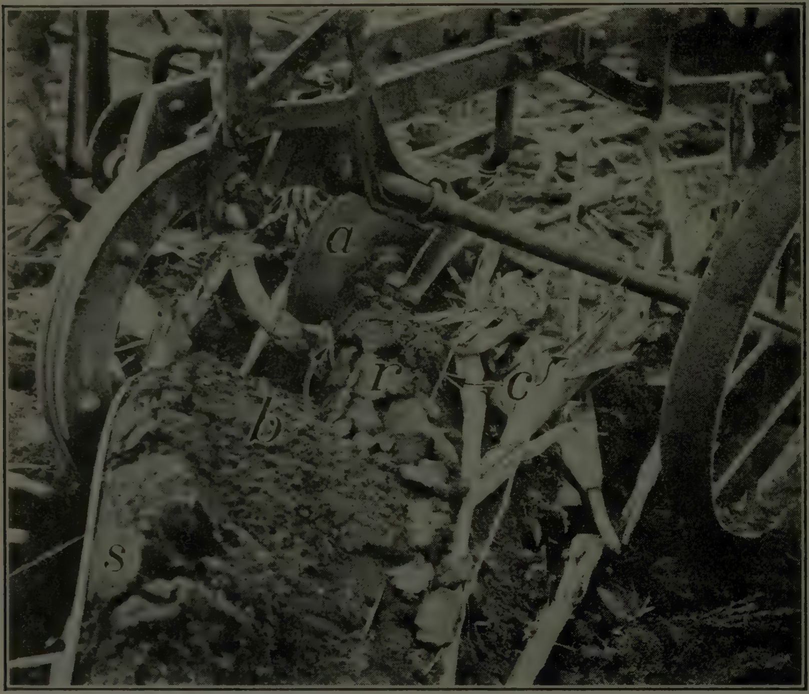


FIGURE 2.—Covering attachments help bury trash. Rolling colter, *a*, cuts crosswise pieces; jointer, *b*, moves roll of soil and trash, *r*, toward open furrow; covering wires, *c*, guide trash under turning furrow slice, *s*

The fin colter is often used on the walking plow in preference to the rolling colter because it is lighter and does not tend to lift the front of the plow. This type of colter consists of a flat knife blade riveted to the side of the share in an upright position just behind the point. It cuts roots satisfactorily but is not so effective as the rolling colter for handling trash. The fin colter needs little attention other than occasional sharpening.

The deflecting colter, a combination of jointer and fin colter, has been found very satisfactory for breaking new ground. Several other types of colters are made for special conditions.

JOINTERS

The jointer, sometimes called the skimmer, is a most important aid to clean plowing. It cuts a shallow furrow 3 inches to 5 inches wide, above the point of the plow bottom, turning a ribbon of sod or soil and trash toward the open furrow. As the new furrow slice is turned on edge by the moldboard, much of the trash moved by the jointer rolls to the bottom of the furrow and is covered by clean soil. (Fig. 2.) If the jointer is not used, considerable trash protrudes from the seams between furrows.

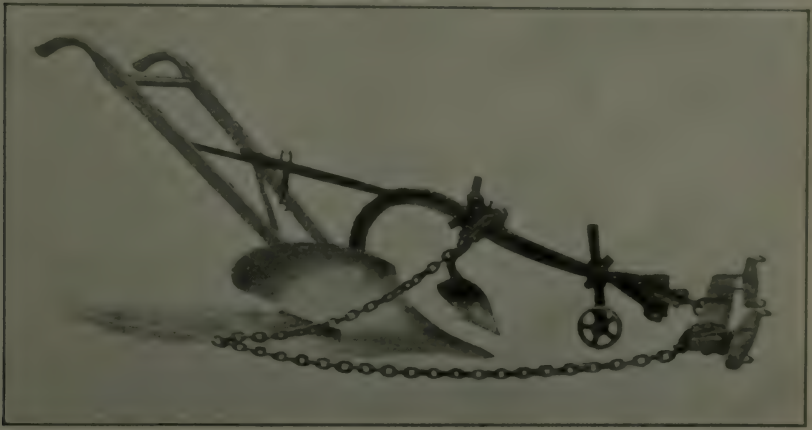


FIGURE 3.—Walking plow equipped with depth gage wheel, jointer, and chain. A 6-foot length of No. 9 wire fastened to the loop of the chain drags under the newly turned soil. This combination is suitable for turning under moderately heavy growths of weeds, cornstalks, or cover crops

The moldboard type of jointer resembles a small plow and is held in position by a shank clamped to the plow beam (independent jointer, fig. 3), or it may be held by a shank clamped to the yoke of the rolling colter. (Combination colter-jointer, fig. 6.) The independent type is more rigid and can be used under more adverse conditions than the combination. Under ordinary soil conditions either type is very helpful in plowing clean, provided the plow has sufficient clearance to allow trash to pass without clogging.

Disk jointers may be substituted for both colter and moldboard jointer. Usually they do not turn so wide a ribbon of soil as do large moldboard jointers, but it is possible to use disk jointers under some conditions where moldboard jointers will not scour. On page 9 are given directions for setting jointers.

CHAINS AND COVERING WIRES

Chains are used chiefly with walking plows, and are effective in covering both weeds and loose trash. (Fig. 3.) Covering wires are preferable for wheel plows under most conditions. They improve coverage considerably with very little cost or trouble. Directions for attaching chains and wires are given on page 10.

OTHER ACCESSORIES

Weed hooks are useful for covering small growth attached to the ground, but are not so effective in loose trash. Shields for deflecting trash to the bottom of the furrow are available. Some types have been used satisfactorily in a number of localities. Flat springs shaped like sled runners and known as broomcorn springs are sometimes used to make trash feed under rolling colters. A special type of rolling colter for walking plows has a cast shoe which answers the same purpose.

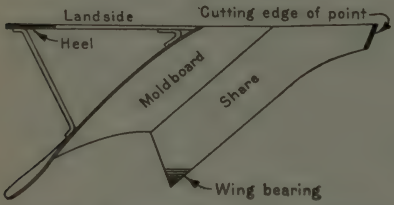


FIGURE 4.—Top view of walking-plow bottom. Heavily shaded parts on the underside of plow carry the weight when share is new. The point is set slightly "to land" to give side clearance

GETTING READY FOR THE FIELD

A plow requires comparatively little care, but if it is neglected time will be wasted in the field when plowing conditions are most favorable and time is most valuable. Therefore any needed repairs should be made before the plowing season. Delays due to worn, broken, or missing parts will thus be avoided and the necessary field adjustments simplified.

Rust is the most common cause of scouring trouble, but is easily prevented. A small can of used motor oil and an old brush or swab may be kept handy for oiling the plow bottom at night or when work is finished. This will prevent rust for a few days, but when the plow is to stand for a longer time the polished parts should be covered with a heavy grease.

Bolts should be kept tight to avoid breakage or misalignment, which may prevent proper scouring and cause other difficulties. Axles, colter bearings, and other working parts should, of course, be lubricated regularly.

PLOWSHARES

The share does the hardest part of the work and requires about half the power used by the plow. It should be kept in good condition, because a badly worn share increases draft and interferes with proper operation.

When a new walking-plow bottom is set on a flat table top or floor, the weight rests on the three points indicated by shading in Figure 4. These are the cutting edge at the point of the share, the small bearing area at the wing of the share, and the heel of the landside. When the plow is at work in hard ground, most of the downward pressure is carried on the underside of the point, while the wing bearing and the landside heel assist in holding the plow bottom level. All other parts back of the cutting edge must clear the bottom of the furrow so that the plow will enter the ground freely and hold its depth.

Long experience has developed the plowshare with a point shaped about as shown in Figure 5. This shape has been found best for penetrating ordinary soil and for standing rough wear. The clearance at *a* is usually referred to as "down suck," and the amount varies with different makes and types of plows. Similar clearance at the side is called "land suck." Manufacturers' instruction books give measurements of suck for their shares. Deep-suck shares, which turn down a little more than regular shares, may be obtained for plowing hard dry ground, but points which turn down too much may make the plow gouge and run unevenly. On the other hand, when a share wears as shown by the dotted line in *b*, Figure 5, it will not enter hard ground properly. The remedy is to replace or reshape the share, depending on the kind of material from which it is made.

The wing bearing of a walking-plow share (Fig. 4) acts like a rudder in keeping the plow level. Too little flatness at the wing bearing will cause the plow to lean toward the open furrow, or "wing down." Too much will cause it to "wing up." One rule is that the wing bearing for a 14-inch walking plow should be 1¼ inches wide measured toward the landside from the corner of the share. However, the proper wing bearing and proper down suck of walking plows depend chiefly on the conditions under which the plow is to be used. For instance, some land, if being plowed in the spring, may require an unusual amount of wing bearing and very little down suck. If the soil is dry the same plow in the same field may need the down suck increased to as much as three-eighths of an inch, or more, and the wing bearing reduced or almost entirely removed. Local blacksmiths usually adjust the suck and the wing bearing according to conditions in their territory and the season in which the farmer is to use his plow. Wing bearing of a steel share may be changed in the field by bending it carefully with an adjustable wrench. Wing bearing is not needed in most wheeled plows, because the wheels steady the plow in the crosswise direction.

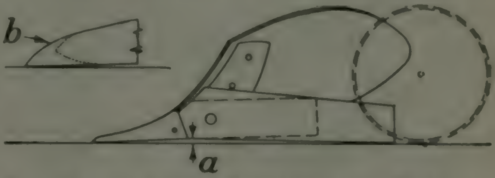


FIGURE 5.—Side view of walking plow. Solid lines show bottom fitted with full length landside; dashed lines show how short landside would be set if rear wheel were used. Clearance, *a*, is usually termed "down suck"; *b*, an enlarged view of a good point; dotted lines show how it may look after hard wear

Plowshares are made of chilled cast iron, crucible steel, or soft-center steel. Chilled cast-iron shares are harder and cheaper than steel shares, and are used largely in sandy or gravelly soils. These shares are hardest on the underside and therefore resist wear best where the wear is greatest. They may be sharpened by grinding off the top of the cutting edge, but can not be changed by forging. Since they are cheap, it is better to put on a new share than to attempt to repair one that is badly worn. It is important that a new share be just like the original, for a cast share that does not fit properly will break easily. Steel shares are made by special processes that produce maximum wearing and scouring qualities for ordinary work. Worn points and cutting edges should be reshaped by forging, but it is impossible for the blacksmith to retain all of the original wearing qualities. The following instructions for sharpening steel shares are furnished by a plow-manufacturing company.

> Build a fire on the forge suitable for this particular work. This is done by banking the fire, allowing only a small opening in the side for the blaze and heat to escape. Commence with the point of the share. Insert this into the fire just far enough to heat the part you wish to draw, never permitting the heat to extend farther back on the share than is absolutely necessary. Draw this down to the proper shape and thickness, which should be as near the original bevel as possible. After the point has been finished, work back toward the heel or wing of the share, never heating more than 1½ inches from the edge and 2½ inches wide. It is important to keep hammering after the steel has changed from a red heat to a black as this makes the edge tough and hard, giving a wearing surface that will last much longer.
>
> If once down the share is not sufficient, reheat; but confine the heated part to the above measurements. In working along the cutting edge, keep it straight. In so doing you will avoid having to go back and reset the edge.

For ordinary plowing conditions the point may be reheated and chilled after the whole share has been reshaped, to give additional hardness and wearing qualities. To do this, heat about 3 inches of the point to a dull cherry red, then quench in water until cold. This treatment is not recommended for the whole share on account of the difficulty of securing an even heat and the danger of warping. If solid stones are likely to be struck it is best not to chill the point, but to depend on hammering until the share is cold to give hardness and toughness.

Sometimes a thin layer of one of the new very hard alloy metals is welded onto the point and cutting edge of a steel share with an acetylene torch. This increases the wearing qualities greatly, but does not materially lessen breakage. It should be done before the share is badly worn.

SPECIAL SHARES

In stony land or in dry, hard ground, where penetration is difficult, "cobblestone" shares with narrow wings which cut less than the full width of the furrow may be used on a wheeled plow. The plow, however, should still turn the same width as a standard share cuts. The "alfalfa" share for alfalfa sod is wider and flatter at the wing than standard, and is set at a blunter angle to the landside to reduce the tendency of the plow to slide around large roots. "Notched-edged" shares are also available for such purposes. Implement dealers can furnish full information about special shares for the plows they handle.

FITTING AND SETTING THE ATTACHMENTS

The following suggestions are for the care and approximate setting of the attachments. Since soil conditions largely affect the operation of both plow and attachments, final adjustments should be made in the field.

THE ROLLING COLTER

The colter should be sharpened occasionally by filing the blade or grinding it carefully so as not to draw the temper. Bearings should be kept greased and adjusted snugly, or replaced if necessary, so that the blade runs true and vertical. If the shank or yoke becomes bent it should be straightened or replaced, unless the blade can be brought to correct position by shims under the colter clamp. A colter that leans sideways or does not run straight forward may crowd the plow toward or away from the furrow so that it fails to respond to changes in the hitch. A colter that wobbles may cause these troubles and also permit trash to wedge between the jointer point and the colter.

Proper setting of the colter depends on field conditions and changes must be made to suit these conditions. Ordinarily the blade should cut one-half to 1 inch wider than the share and should be the width of two fingers above it. In soft or easy plowing the hub of the colter may be ahead of the point, while in hard plowing it may be necessary to set it back of the point. Where stones are common, the colter of a light plow is sometimes set ahead and as deep as possible so that the edge of the colter helps to protect the point of the share, rolling it out and over the stone with less injury to the plow than if the point had struck. When plow and colter are working properly a full, straight furrow wall is formed and provides good bearing for the rear wheel or landside. A ragged furrow wall is usually due to narrow or shallow setting of the colter, or wrong setting of the plow hitch. Considerable pressure is needed to force the rolling colter into the ground and to provide this the hitch should be set a little higher on the bridle of a horse plow than if no colter were used.

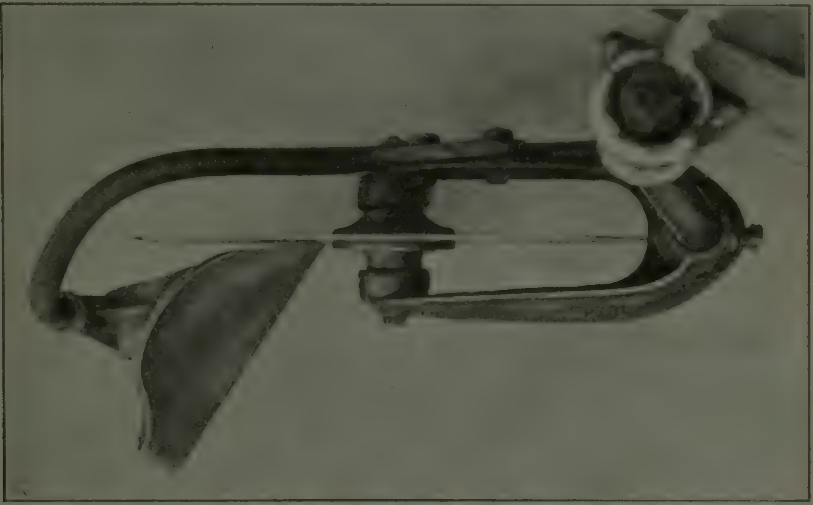


FIGURE 6.—Proper shape and setting of jointer point against colter blade

THE MOLDBOARD JOINTER

The jointer point should be shaped about as shown in Figure 6, so that when it rests lightly against the colter there will be a V-shaped clearance space back of the point. This permits bits of trash that lodge against the jointer edge to work their way out, and provides for taking up slight wear on the point by twisting it toward the colter. As wear increases other adjustments must be made. For this purpose some jointers are provided with a slot in the frog to allow the blade to be swung toward the colter. In other types the blade back of the point may be ground to give clearance. Some types of jointers have cheaply replaceable points.

The jointer should be set just far enough behind the colter hub to prevent dirt and trash wedging against it, and low enough to cut a 3-cornered ribbon of dirt about 4 inches wide and usually not more than 2½ inches deep at the point. The cutting edge of the jointer should not be completely buried, since in that case the slice of dirt would not be cut free. In setting an independent jointer care should be taken not to crowd the colter, as this will cause a ragged furrow wall and may keep the colter from turning or make the plow run unsteadily.

When a jointer is used without a rolling colter its point should be set approximately over the point of the share. (Fig. 3.) It should cut three-eighths to three-fourths of an inch wider than the plow and 1½ inches to 2½ inches deep.

Sometimes the jointer fails to scour, or throws trash against the next beam of a gang plow. This may be prevented by twisting the jointer or by tilting it forward or backward. Most jointers have adjustments which permit these changes.

THE DISK JOINTER

The center of the disk jointer should be approximately over the point of the share. Usually it should cut 2 or 3 inches deep, and the angle of the disk toward the furrow should be so set that its slice just clears the next bottom or the furrow wheel.

CHAINS AND COVERING WIRES

A log chain is a valuable aid in covering trash with walking plows. One end is fastened to the doubletree back of the furrow horse and the other to the plow beam. (Fig. 3.) The chain is allowed to drag back almost to the plowshare, forming a loop that will drag the trash under the turning furrow slice without the chain itself being caught. A short length of heavy wire fastened to the loop and dragging back under the furrow helps to hold the chain in position. Some experimenting may be necessary in order to adjust the chain properly.

On wheeled plows, covering wires instead of chains are generally used. These are pieces of heavy soft-iron wire 10 to 12 feet long. (Fig. 7.) One covering wire is usually tied to the lower end of each colter shank (Fig. 8), the wire running back over the lower part of the furrow slice and under the turned soil. Sometimes it is advantageous to pass this wire through the colter yoke to regulate its height. Another wire is fastened to the axle or hitch to drag just over the furrow wall, and additional wires are often fastened to the plow frame or axles. Each wire should drag far enough under the furrow slice to give it sufficient tension to hold trash down and to bend over long pieces that would otherwise not be covered. All wires should be fastened rigidly to reduce swinging so they will not drag under the plow bottoms when making turns with the plow lifted. (Figs. 8 and 9.) Kinks may cause the wires to tangle and drag trash or to break. It is a good idea to keep a few extra wires on hand.

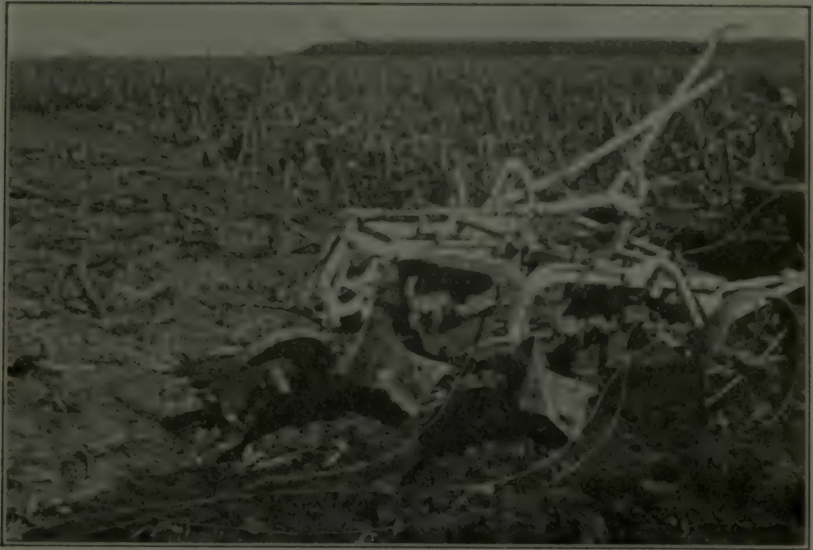


FIGURE 7.—Plow equipped for clean plowing. Note ample clearance, large rolling colters, jointers, and covering wires

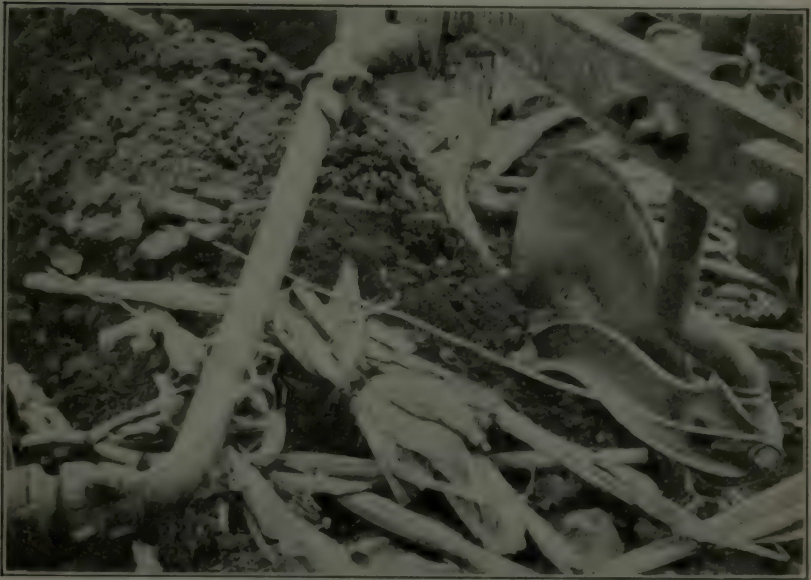


FIGURE 8.—Method of attaching covering wire to colter shank and plow axle

FIELD ADJUSTMENTS[3]

A plow, to do its best work, must be adjusted to suit soil conditions. Adjustments should be made from time to time because there are variations in the soil on different parts of the farm, and from season to season as rains occur and crops are rotated. The necessary field adjustments may be made quickly and easily, and the behavior of the plow is the best guide to adjustments that should be made.

Since the entire power of the team or tractor is applied to the plow through the hitch, no other adjustment can entirely remedy the fault if the hitch is wrong. Poor work, excessive wear on the shares, and wasted power are likely to result. The hitch should be so set that the plow runs level at the desired depth and width of cut, without much guidance from the wheels, or from the handles in the case of a walking plow.

HORSE PLOWS

DEPTH

The depth cut by a walking plow in good condition is affected by the height of the team, the length of the traces, the height of the cross clevis above the furrow sole, and the weight of the eveners. When plowing, a horse works most comfortably if the traces are moderately long. The theory that a short hitch saves power does not necessarily apply to the plow. What the short hitch actually does is to raise the front end of the plow and cause it to run shallower unless the height of the cross clevis is changed to compensate.

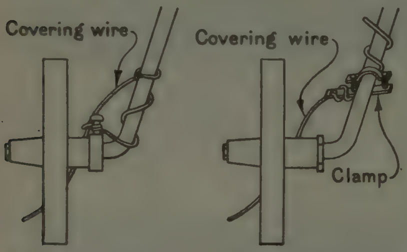


FIGURE 9.—Methods of fastening wires rigidly to plow axles in order to avoid swinging when making turns

Depth adjustments should be made by moving the cross clevis (fig. 10, *a*) up or down on the plow bridle. (Beam clevis fig. 10, *b*.) The higher the clevis pin *p* is above the bottom line of the share the deeper the plow will run. Since these adjustments of the walking plow are simple and generally understood they give little trouble in ordinary ground as long as the share is in good condition. If the share becomes badly worn the plow may fail to penetrate when the hitch is in the ordinary position, especially in hard ground. The only satisfactory remedy is to put on a share with a good point.

The hitch of a sulky or gang plow, or of a walking plow with beam wheel, should be adjusted for depth just as that of a plain walking plow. The wheels should be set to steady the plow and hold it at uniform depth across soft places. When the hitch of a wheeled plow is properly adjusted, the rear wheel should carry about the same weight as either of the others. One way to test height of hitch is to hold the land-wheel lever unlatched for a short distance. If the hitch is properly adjusted the operator should be able to hold the plow at the desired depth with little effort. If the hitch is too high on the bridle, there will be too much weight on the front wheels and the plow will tend to run deep as soon as the lever is unlatched. On the other hand, if the hitch is too low on the bridle the plow will not run deep enough.

---

[3] A more complete discussion of plow adjustments is given in Ohio State University Extension Bulletin 80, Plows and Good Plowing, with special reference to European cornborer control.

WIDTH

The number of horses hitched abreast, the length of the eveners, and the way the horses are reined, affect the running of a plow. For best operation the main evener clevis should be near a line centered on the plow beams (line of draft of bottoms, fig. 11) and the horses should be reined to walk straight ahead.

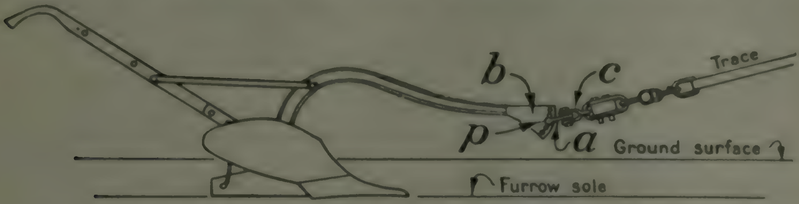


FIGURE 10.—Depth of plowing depends chiefly on height of clevis pin *p* above line of furrow sole: *a*, Cross clevis; *b*, beam clevis; *c*, twisted clevis

When a 14-inch plow is hitched behind a 2-horse team, and a 38 or 40 inch evener is used, the width adjustment is very simple. If the plow is not cutting wide enough, the twisted clevis (fig. 10, *c*) should be moved nearer to the open furrow on cross clevis *a*. If it is cutting too wide, clevis *c* should be shifted away from the open furrow. There is very little side draft in this case, because the center of the doubletree is almost in line with the plow beam. The same principle applies to sulky and gang plows, but where four horses are used abreast on a gang plow, side draft will cause more or less trouble. This difficulty is illustrated in Figure 11. In order that the 2-bottom, 14-inch plow shall pull straight ahead with least draft, clevis *c* should be set on the line of draft of the bottoms, about halfway between the plow beams, probably 19 inches from the furrow wall. But this is not possible with three horses on the land, because the center of the evener will be 28 or

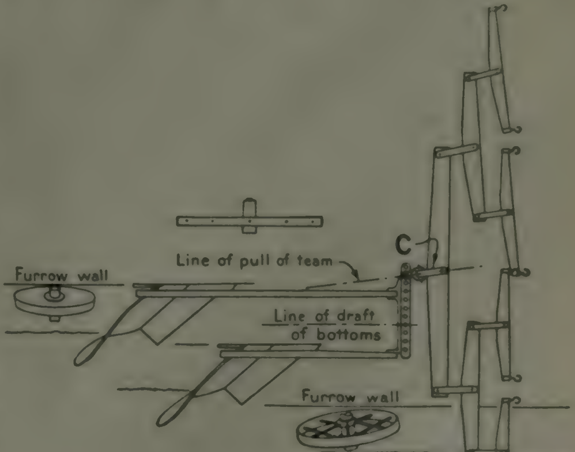


FIGURE 11.—Hitching four horses abreast to a 2-bottom plow results in side draft

30 inches from the furrow wall even though short singletrees are used. Therefore, to limit the plow to its proper width of cut it is necessary to hitch several inches off center, as shown. Hitching to the corner of the plow in this way tends to pull it cornerwise instead of straight ahead, just as if the team were hitched to the corner of a harrow instead of at the center. The front-furrow wheel may be set at an angle as shown in Figure 11 to help overcome this tendency, but power is wasted and the horses are crowded and worried. The difficulty may be overcome by using a tandem hitch; that is, with two or three horses on the rear evener and two ahead.

SET OF WHEELS

Properly adjusted wheels hold a plow steady with little attention from the operator. They help to overcome the effects of side draft and to lighten the load on the team or tractor. Quality of plowing, especially with gang plows, may be greatly improved by using the levers controlling the wheels to keep the plow level and the furrow crowns uniform. The front-furrow wheel of a horse plow serves as a width gage. On some types it may be moved in or out to change the width of cut. If side draft causes the plow to pull toward the open furrow this wheel may be set to lead to the "land" as in Figure 11.

Two types of rear-furrow wheels are used. Either should be set below and outside the landside enough to carry practically all of the side and vertical pressure at the rear of the plow, and should be angled slightly away from the furrow wall. One type, known as rolling landside, is held in a fixed position by a strong bracket. The other type is adjustable and its proper setting depends on soil conditions and on the design of the plow. Ordinarily there should be room to slip the fingers under the heel of the landside. In waxy soils it may be advisable to give less clearance under the landside, while in hard ground slightly greater clearance may improve penetration. Proper setting of an adjustable rear wheel is often neglected, with consequent loss of efficiency. Manufacturers' instruction books give correct settings for their plows.

TRACTOR PLOWS

When a tractor plow is running properly the weight is distributed almost evenly on each front wheel and on the rear wheel or landside. The plow does the best work and pulls easiest when set this way. Proper setting of the plow hitch and the tractor drawbar are explained in the following paragraphs.

SETTING THE HITCH FOR DEPTH

Four common types of hitches used on tractor plows are shown in Figure 12. The same principles govern the setting of them all. The hitch should be adjusted for the depth of cut by raising or lowering bolt *p* at the rear end of the floating link *l*. Raising *p* causes the plow to run deeper unless the wheels prevent, and lowering *p* makes the plow run shallower as in the case of the horse plow. (Fig. 10.)

If the plow runs unevenly or fails to hold the depth for which the wheels are set, the shares should be examined to determine whether the points are in good condition. If the points are good, the tractor drawbar may be lowered. If this does not remedy the trouble the hitch may be raised slightly on the end of the plow beams. (Fig. 12, *p*.) To secure penetration it is better to set the tractor drawbar low than to hitch high on the plow, as raising the plow hitch too high in an effort to make dull shares penetrate may result in "nosing" as shown in Figure 13, A. On the other hand, if the plow tends to run too deep and the front wheels are carrying too great a load, the levers may be hard to shift. In that case the hitch at *p* should be lowered; then, if necessary, the tractor drawbar should be raised until all three wheels carry about the same load. Raising the tractor drawbar too high will make the tractor difficult to steer.

The full-floating type of hitch (fig. 12, D) allows the plow to be carried on all three wheels when lifted. Hitches like that shown at C have a chain or rod which holds the front end of the plow down and the rear end up when the plow is lifted, so that all the weight is carried on the two front wheels. Hitches like A and B act in the same way as that at C because the link *l* is short. Plows with hitches of this type are usually referred to as 2-wheeled plows though, as previously mentioned, such a plow frequently has a rear wheel mounted on a rigid bracket and known as a rolling landside. When plowing it carries the load at the rear of the plow. The hitch setting should be the chief means of controlling depth, and levers should be used only to accommodate the plow to soil differences in the field and to hold the plow level crosswise.

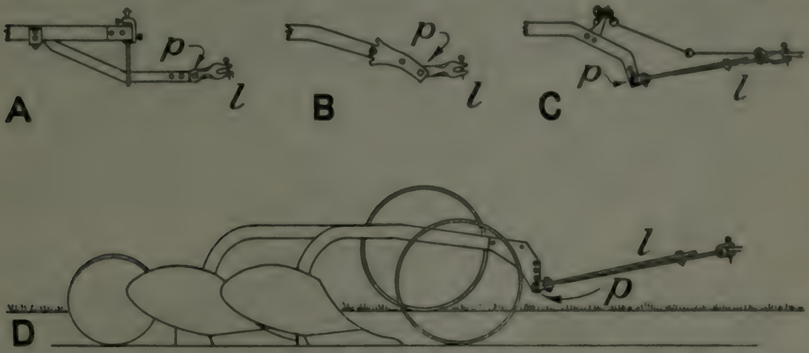


FIGURE 12.—Four hitches commonly used on tractor plows. The height of the bolt *p* above the bottom of the shares, and the height of the tractor drawbar control the depth to which the plow tends to run. If the floating link *l* is short as in A and B the bolt *p* may be set higher but the flexibility will be less than if a long link is used as in C and D

DIVIDING SIDE DRAFT

Hitching off center on either the plow or the tractor causes side draft. The amount of side draft and the trouble it may cause depend on the draft of the plow and the distance that the hitch is off center. (See Figure 11 and the discussion of the side draft in horse plows, p. 13.)

The line of draft of the bottoms (line B, figs. 14 and 15) is approximately midway between the beams in the case of a gang plow, or in line with the beam of a single-bottom plow. If this line of draft is almost directly behind the center of the tractor (line A, fig. 14), as when a 2-bottom, 16-inch plow is drawn by a standard-width tractor, side draft will cause little trouble. It is more likely to cause difficulty when a wide-tread, general-purpose tractor is used with a relatively narrow plow (fig. 15), especially when the ground is hard and the draft is heavy.

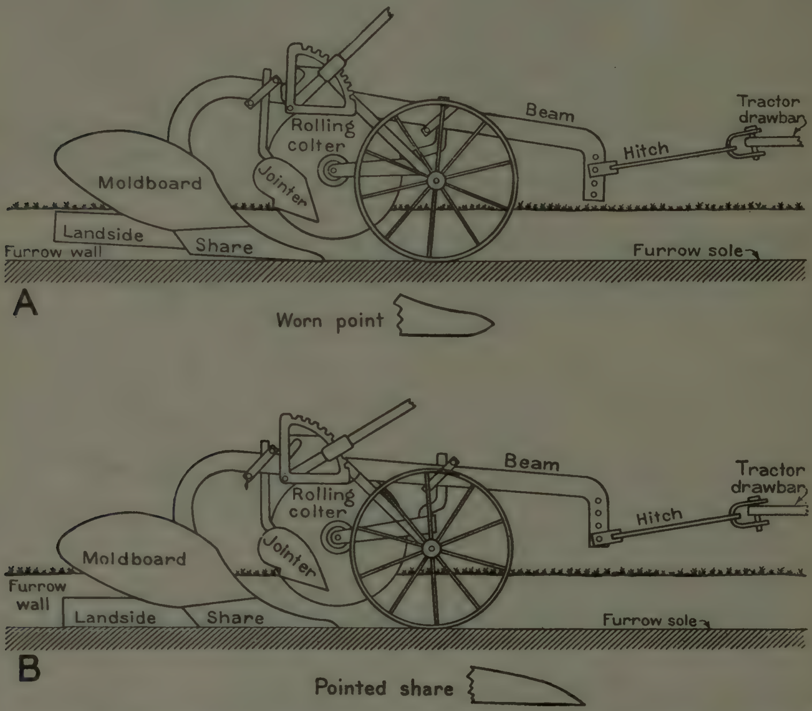


FIGURE 13.—Good shares and proper hitch adjustments are necessary for good work: A, Share with worn point fails to penetrate ground properly. Hitching high on beams to force plow deeper throws it "on its nose," with landside riding up. B, A correctly pointed share draws the plow into the ground. The hitch should be set low enough at beams to hold plow level and in balance at depth desired

If the plow is relieved of side draft by hitching the clevis on the drawbar near line B the tractor may be pulled sidewise. On the other hand, if the tractor is relieved of all side draft by hitching the clevis in the middle hole of the drawbar, the plow will probably pull cornerwise and run poorly. The best remedy for these difficulties, if much plowing is to be done, is to set the tractor drivewheels closer together, to bring the center line of the tractor as close as possible to the line of draft of the plow bottoms. This can be done on the newer general-purpose tractors in several ways, as by reversing wheels with offset hubs, by sliding wheels on the axle, by using extension rims or overtires on the inside edges of the drivewheels, or by means of telescoping axles.

If it is not possible to narrow the tractor tread, the plow clevis may be hitched midway between the center drawbar position and the line of draft of bottoms, as indicated in Figure 15, and an adjustment made for width of cut. If the plow tends to pull cornerwise, the clevis on the drawbar may be shifted nearer to the line of draft of bottoms, thus putting more of the side draft on the tractor, then readjusting for width of cut. On the other hand, if the front or rear wheels of the tractor are pulled sidewise to an objectionable degree, more of the side draft may be shifted to the plow by moving the clevis toward the center of the drawbar and readjusting for width. If the difficulty can not be overcome in this way, it may be necessary to lengthen the plow hitch.

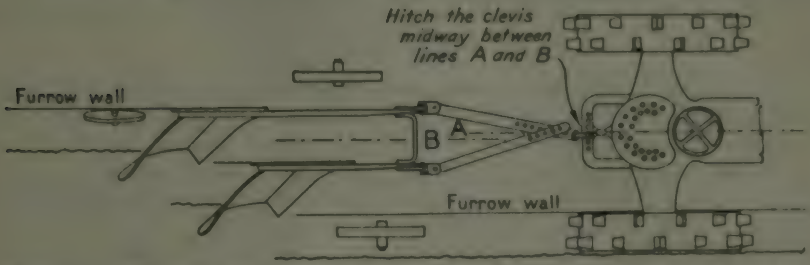


FIGURE 14.—There is little side draft when a 2 or 3 bottom plow is drawn behind a standard-width tractor. For best results, hitch point on tractor should be midway between lines A and B, as shown

ADJUSTING FOR WIDTH OF CUT

Adjustments for width of cut should be made on the plow hitch and not by shifting the tractor drawbar or the point of hitch on the drawbar.

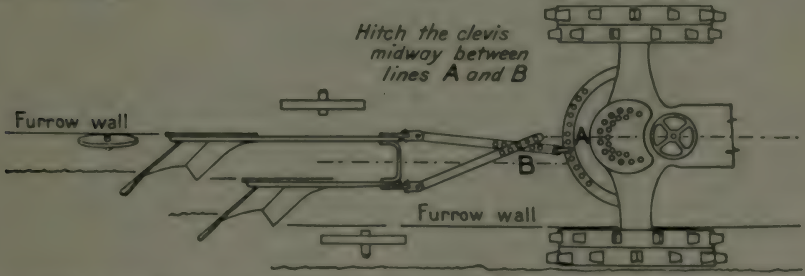


FIGURE 15.—Plow drawn by a wide tractor. The side draft should be divided between plow and tractor by setting tractor drawbar halfway between center line of tractor and line of draft of plow bottoms, as shown

On plows having a V-type hitch (figs. 14 and 15) one side of the V should be lengthened or shortened. Some plows are provided with an offset clevis (fig. 12, B) which may be set to the right or left on the end of the beam or turned upside down, giving four width settings. Other plows have a pivoted hitch bar with a clamp on the front cross member of the plow (Fig. 12, A) which holds the hitch at the proper width and depth setting.

SETTING WHEELS AND LEVERS

The information on page 14 concerning proper setting of wheels and levers for horse plows applies also to tractor plows, except that the front furrow wheel of a tractor plow is not intended to run against the furrow wall to gage the width of cut, nor can it be set at an angle. It may be repeated that close attention to the levers improves the uniformity and appearance of the work.

SAFETY HITCHES

An overload release should be used at all times when plowing. Break pins are fairly satisfactory where obstructions are few. The bolts in the slotted holes behind or in front of the break pin should be tightened just enough to prevent excessive wear on the pin.

Many of the newer tractor plows are equipped with spring-controlled releases. Two types of these are available. One type must be reset by hand, while the other snaps back to working position automatically and the plow may be recoupled from the tractor seat. There are also safety releases which attach to the tractor drawbar.

The release, whether spring or break-pin type, should be kept in good working order and so adjusted that it will function before the plow is subjected to severe strains. Bolts should not be substituted for wooden break pins.

FIELD PRACTICES

Plowing should be done when soil-moisture and weather conditions are suitable. It is easier at such time to keep the plow running properly, less fuel is used, and less time is required. In many sections it is good practice to plow in the fall and avoid the chance of wet weather or lack of time in the spring. However, land that washes badly had better be plowed in the spring.

LAYING OUT FIELDS

Finishing a wedge-shaped land is troublesome and wastes time. Such lands can usually be avoided except in irregular fields. It is not necessary to measure off lands each season if the field is once laid out accurately and marked with permanent stakes set in fence rows. It is then easy to place backfurrows in last season's dead furrows and keep the field level, or if dead furrows are needed for drainage they can be kept straight and left open. Different methods of laying out lands are described in Farmers' Bulletin 1045, Laying Out Fields for Tractor Plowing, and many of the suggestions apply also to plowing with horses.

PLOWING SPEEDS

The proper speed for plowing depends on the condition of the soil and the type of bottom used. When a tractor is overloaded the speed may be reduced enough to lower the quality of the work done. The plow should be pulled with sufficient speed to turn the furrow slice over completely. This results in a wider-open furrow to hold trash, and usually in a cleaner, smoother job than is obtained at lower speeds. In new or stony ground where the plow is likely to strike solid objects, it is usually advisable to avoid high speeds and when plowing with a tractor to use a safety release in the hitch.

CLEAN PLOWING

The following pages are devoted to the special precautions that should be observed when selecting and operating plowing equipment where clean plowing is especially desirable, as where the European corn borer or certain other insect pests are present.

CHOICE OF EQUIPMENT

Field tests show great differences in the covering ability of plows. Therefore, when a new plow is being purchased, its ability to plow cleanly should be considered with special reference to the features discussed in the following paragraphs. Clean plowing depends as much upon the operator as upon the plow, and good work can be done with most of the plows now in use provided they are equipped with suitable covering attachments and are adjusted as has been described.

The choice between tractor power or horse power for plowing depends more on other factors than on requirements for clean plowing. The operator of a horse plow is in an excellent position to watch its work and to keep it operating uniformly. When there is a tendency to clog he can see it and dislodge the obstruction at once. On the other hand, tractor plows usually have greater clearance, are equipped with more effective covering attachments, and operate at higher speeds than horse plows. All of these qualities tend to improve coverage.

Single-bottom plows are satisfactory for small acreages. Many plows having more than one bottom, especially in the smaller sizes, lack clearance and are impeded considerably by clogging, or do not have room enough for the proper attachment and operation of colters and jointers. Plows having more than two bottoms do not turn uniform furrows where the field has been ridged by cultivation unless the ridges are first leveled by disking. This fact favors two large instead of three small bottoms of equivalent width.

On mellow soils the larger bottoms, such as 16-inch and 18-inch, usually do cleaner plowing than smaller bottoms; but on heavy or waxy soils some large bottoms leave the ground very rough, with breaks in the furrow slice. Under such conditions, where small bottoms must be used to turn the soil smoothly, it is often best to dispose of trash before plowing.

Shape of plow bottoms is just as important as size. The bottom should make a wide, open furrow to hold the trash turned by the following bottom or at the next round, and should turn the furrow slice over completely and uniformly. Small differences in plow shapes are difficult to distinguish. A good way to select a suitable type of bottom is to see it in operation or, better, to give it a thorough trial in the soil where it is to be used.

COVERING ATTACHMENTS

To do clean plowing in cornstalks or other crop refuse, plows must be equipped with auxiliary covering attachments. (Pp. 3 to 6.) These devices work in front of the turning furrow slice to move cornstalks or other trash toward the open furrow. It is, therefore, very important to have enough clearance at the points where clogging occurs, as shown in Figure 16, to permit these devices to do their work and permit trash to pass through without interference. It is desirable to have a minimum horizontal distance of 21 inches or more measured diagonally from the top of the moldboard at the shin to the back of the beam ahead, or to the tire of the furrow wheel. The axles and braces should be so placed that there is room for the use of colters as large as 18 inches in diameter. Both plow and hitch should be free from projecting parts which might drag trash. Provision should be made for easy adjustments.

The necessity for covering attachments in order to do a good job of clean plowing in whole cornstalks or almost any kind of trash was demonstrated by an experience with a 2-bottom 14-inch plow in a field of standing stalks. After plowing, 25 bushels of trash per acre were picked up from the land where no covering attachments had been used while only 2½ bushels per acre were left where rolling colters, moldboard jointers, and covering wires (fig. 7) had been used. These attachments may be used together satisfactorily on wheeled plows under most soil conditions, although some difficulties are encountered with moldboard jointers in soils that do not scour well.

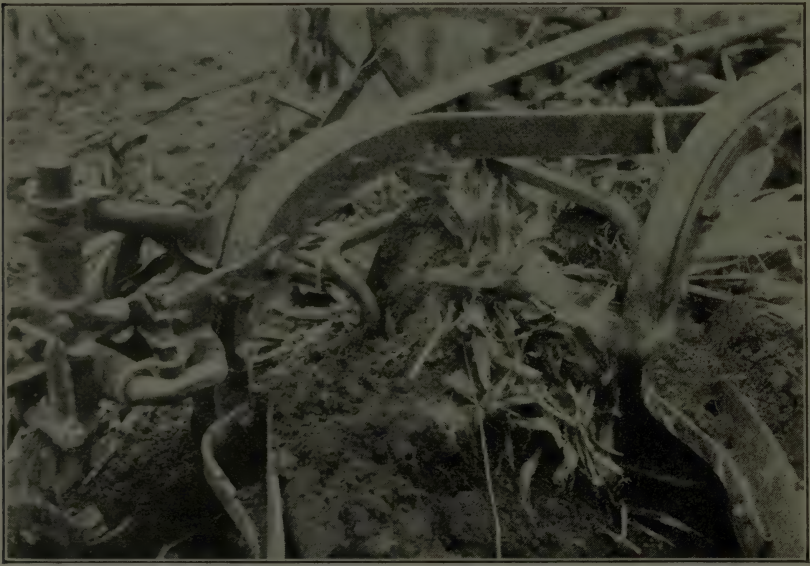


FIGURE 16.—Clogging caused by insufficient clearance between the jointer and the bottom ahead of it

Some of the trouble experienced is due to worn jointer points and may be avoided by keeping the points in good repair and properly adjusted against the colter. (Fig. 6.) Small or dull colters which fail to cut the stalks, especially when they are damp and tough or when the soil is soft, also interfere with the operation of the jointers. Large, sharp colters remedy this fault. Lack of proper clearance between the plow bottoms is likely to cause stalks to clog against the jointers. This difficulty is seldom found with plows having 21 inches or more of clearance between the top of the moldboard and the beam ahead. Disk jointers and covering wires may be used together satisfactorily in plowing under cornstalks with wheeled plows. It is likely that they can be used under more adverse soil conditions than moldboard jointers. Types of trash shields which are free from clogging may be used satisfactorily with either type of jointer.

Rolling colters and covering wires or trash shields may be used together without jointers, but the work will not be so clean as when jointers are used also. Covering wires or chains are sometimes used alone but are not sufficient to do clean work.

The jointer and chain may be used satisfactorily on walking plows (fig. 3) without the rolling colter, because the operator can easily free the plow of stalks which may catch on the jointer shank. This arrangement of attachments is often used where the soil contains small rocks which might catch between the colter and plowshare or force the plow out of the ground if a standard rolling colter were used.

PRACTICES THAT PROMOTE CLEAN PLOWING

Disposing of crop refuse may be made easier by simple precautions in other field operations. For example, cultivation that does not ridge the soil permits better plowing for the following crop and also is helpful if other methods of trash disposal are used. Ridging is more likely to result when corn is drilled than when it is planted in checkrows, but the root clumps of single stalks are less troublesome than those of stalks growing in a hill. It is usually easier to do clean plowing where the corn has been drilled, provided the ridges are low.

Disking before plowing may be harmful if done when the soil is in condition to pack. However, when the field is dry, disking with a sharp, weighted disk breaks up the crust, reduces ridges, and cuts up stalks. Under these condutions, the plowing may be improved, and the number of stalks uncovered in cultivation will usually be reduced.

Pasturing cornstalk fields reduces the quantity of trash to be turned under, but the soil may become packed by livestock tramping over it when wet, and this makes good plowing difficult.

Stubble fields to be plowed with a walking plow are often first rolled or dragged with a weighted drag. If one operation is not enough to break the stubble down, it should be repeated in the opposite direction. Lands to be dragged should be laid out the same as plowlands, and in going over them the last time the implement should travel in the same direction as the plow in order to leave the stubble pointing forward. If a tractor is used, an extension rim on the land wheel will break down stalks and stubble.

Mechanical corn pickers usually leave the stalks in good condition to be turned under if the plowing can be done in the same direction that the picker traveled and if the stalks are not pulled loose. It is rather difficult to plow in the opposite direction until the stalks have been weakened by being weathered through the winter, or cut up with a disk harrow or stalk cutter.

Sometimes it is impossible to do clean plowing in whole cornstalks, either because of soil conditions or on account of using a poorly equipped plow. In such cases, if the control of the European corn borer is an object, removal of stalks may be necessary.[4] This should be done before plowing, for picking up uncovered stalks by hand after plowing is a back-breaking job.

Where surface drains are not needed it is good practice to place backfurrows in the old dead furrows to keep the field level, or to plow around the entire field, thus reducing the number of backfurrows and dead furrows.

It is best to remove cornstalks from headlands before plowing. Stalks standing where backfurrows are to be placed may be cut and thrown aside or raked up and burned, preferably before the weather is suitable for plowing, so that no time is lost.

If crop refuse has not been removed, the backfurrows may be prepared for plowing by running the disk harrow on each line, then returning in the same path. If a tandem disk is used, the rear gangs should be set straight to avoid filling up the depression made by the front gangs. This depression is needed to hold trash turned by the plow at the first round and also helps to keep the backfurrow level. Sometimes trash on the line of the backfurrow is mashed down by the tractor drivewheel before making the first round. This improves the looks of the backfurrow, but disking or harrowing after plowing may uncover much of the trash. In finishing dead furrows, the work should be so managed that if the land has been ridged by cultivation the last furrow thrown each way will be cut from between the ridges.

It is usually necessary to plow at least 6 inches deep in order to place trash so far under the surface that it will not be dragged out by the operations of fitting, seeding, or cultivating the ground. For the purpose of covering trash, it is better to plow 7 to 8 inches deep if possible. Plowing deeper than 8 inches usually results in little or no improvement in coverage, except perhaps in sandy soils. Where rock ledges prevent the plow running 6 inches deep, trash over the ledges should be removed before plowing. It may be scattered over the adjoining land and plowed under, or it may be burned.

PRECAUTIONS TO BE TAKEN AFTER PLOWING

When mellow soils are properly plowed, the trash is well buried and the furrows form a continuous granular surface which may easily be worked into a seed bed. On the other hand, heavy soils are often turned up by the plow in large clods or lumps with open spaces between. Trash may be so poorly covered by these clods that the operation of fitting the seed bed will drag pieces to the surface or leave them partly exposed. Under these conditions a corrugated roller, a packer, a spike-tooth harrow, or a plank drag may be pulled in the direction of plowing to break up the clods and fill the holes before the ground is worked with other implements.

The disk harrow should be used with care in preparing a seed bed where trash has been plowed under, since disks set at too great an angle turn up much buried material. The disks may be set at a slight angle and weighted to secure penetration. If a spring-tooth or a spike-tooth harrow is used it should be run shallow.

---

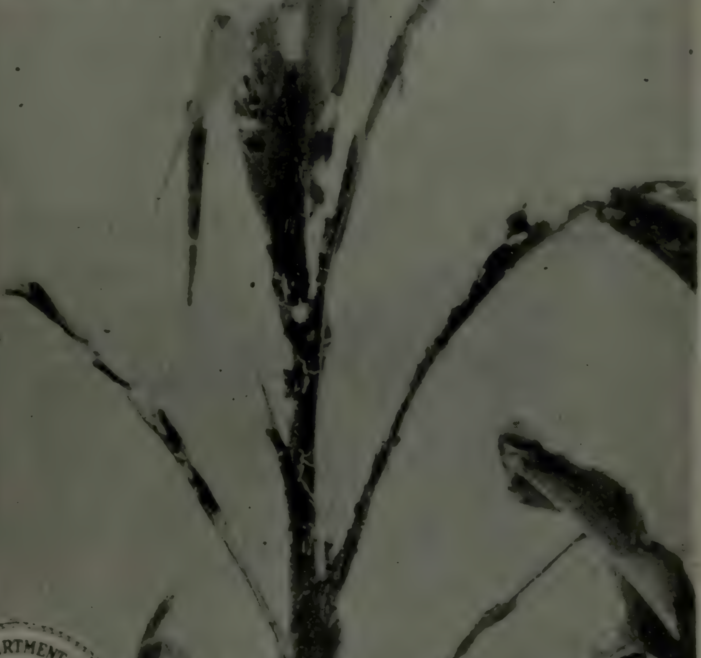
[4] Miscellaneous Publication 56, Low-Cutting Devices for Harvesting Corn, and Miscellaneous Publication 142, Construction of Sled-Type Cornstalk Shavers, describes equipment for use in stalk disposal

U. S. GOVERNMENT PRINTING OFFICE: 1932

For sale by the Superintendent of Documents, Washington, D. C.

U. S. DEPARTMENT OF
AGRICULTURE
FARMERS' BULLETIN No. 1691

HOW TO CONTROL GRASSHOPPERS in CEREAL and FORAGE CROPS



ALTHOUGH the farmer usually does not notice grasshoppers until they have reached a considerable size, they begin to injure his crops soon after they hatch. They should therefore be detected and combated while they are young and small, so that time, labor, and material, as well as crops, may be saved.

Destroying grasshopper eggs by fall plowing, disking, or harrowing is recommended where such destruction is practicable.

Applying poisoned-bran mash is the most practical means of controlling grasshoppers. The poisoned mash should be put out usually between 6 and 10 a. m., or as soon after sunrise as air temperatures reach 70° to 80° F. At these times the grasshoppers are on the ground doing their first feeding of the day. Exact temperatures at which maximum feeding occurs differ with the locality and the species of grasshoppers. The mash should not be put out while the temperature is below 70° or above 85° or during cloudy or inclement weather.

In mixing and distributing the poisoned mash care should be taken to prevent injury to persons or farm animals.

The best results can be obtained when all the farmers in a community cooperate.

This bulletin is a revision of and supersedes Farmers' Bulletin 747, Grasshopper Control in Relation to Cereal and Forage Crops.

Washington, D. C. Issued April, 1932

HOW TO CONTROL GRASSHOPPERS IN CEREAL AND FORAGE CROPS

By J. R. Parker *and* W. R. Walton, *Senior Entomologists, and* R. L. Shotwell, *Assistant Entomologist, Division of Cereal and Forage Insects, Bureau of Entomology*

CONTENTS

Page

Principal kinds of injurious grasshoppers 1

Conditions favorable to outbreaks of grasshoppers 4

Life histories and development of grasshoppers in general 4

Natural enemies 6

Control measures 6

  Destroying grasshopper eggs 6

  Using poisoned bait 7

  Additional suggestions for control 11

Organizing for grasshopper control 12

GRASSHOPPERS have always been among the principal insect enemies of agriculture. Serious outbreaks still occur over large areas at irregular intervals, and the aggregate annual loss due to grasshoppers even during years not marked by outbreaks is sufficient to class these insects as a major pest.

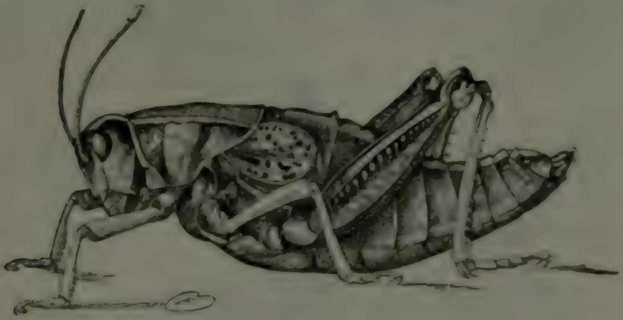


Figure 1.—Southwestern lubber grasshopper. Adult female. Natural size

PRINCIPAL KINDS OF INJURIOUS GRASSHOPPERS

Many kinds of grasshoppers injure grains, grasses, and forage crops throughout the United States. The most important are the southwestern lubber, the differential, the 2-striped, the lesser migratory, the red-legged, the Carolina, and the pellucid or clear-winged grasshoppers.

The southwestern lubber grasshopper (*Brachystola magna* Gir.) (fig. 1) is very large, usually pale green, speckled, and marked with pink and brown, and is wingless throughout its entire life. This species lives in the semiarid regions of the Southwest. It sometimes becomes injuriously abundant on the cattle ranges and dry farms of New Mexico and Arizona, but is found throughout the Great Plains area from Wyoming and South Dakota to New Mexico and Texas.

The differential grasshopper (*Melanoplus differentialis* Thos.) (fig. 2) is usually yellowish, with clear, glassy hind wings, and averages nearly 1½ inches in length. Its hind legs are usually distinctly marked with yellow and black, the color arranged in chevron-shaped bars on the sides of the thighs. It is found throughout nearly the entire United States, although rarely in the Atlantic States. This grasshopper is chiefly injurious in the Middle Western and Southwestern States.

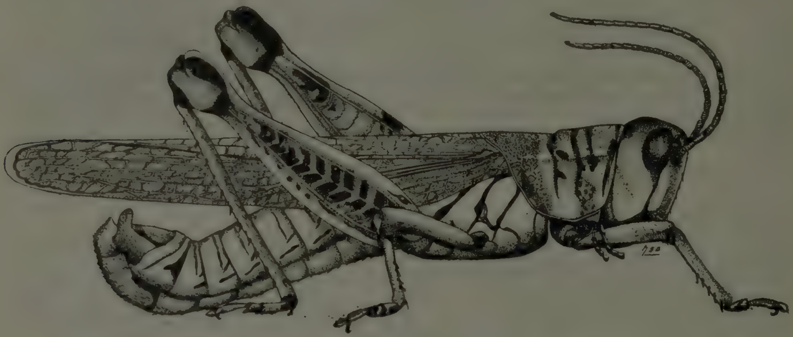


FIGURE 2.—Differential grasshopper. Adult male. Twice natural size

The two-striped grasshopper (*M. bivittatus* Say) (fig. 3) is compact and yellowish, bearing two yellow stripes from the forehead down each side of the otherwise brown back, and having nearly colorless hind wings. It ranges from 1 to 1½ inches in length. This species is found from southern Canada to Mexico, except in the South Atlantic States.

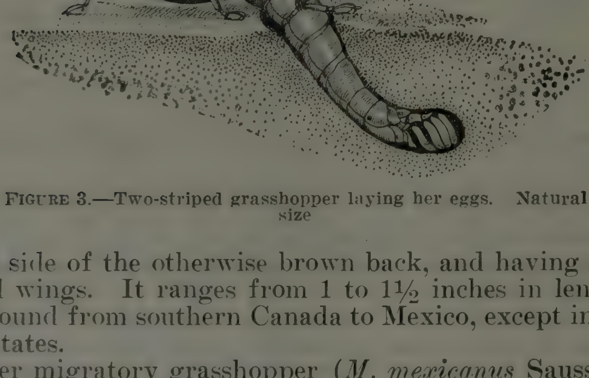


FIGURE 3.—Two-striped grasshopper laying her eggs. Natural size

The lesser migratory grasshopper (*M. mexicanus* Sauss.) (fig. 4) is reddish brown, bearing a distinct patch of black on the neck or collar and averaging about 1 inch in length. Although comparatively small, it is a strong flier and sometimes does immense damage to crops. It is found throughout nearly the entire United States, but is chiefly injurious in States west of the Mississippi River.

The red-legged grasshopper (*M. femur-rubrum* De G.) (fig. 5) is one of the most widely distributed of all the injurious species.

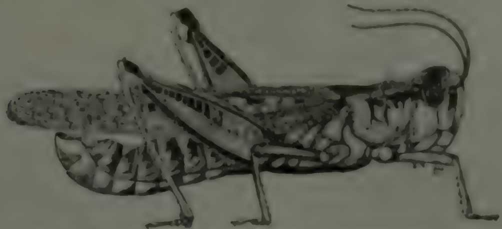


FIGURE 4.—Lesser migratory grasshopper. Adult male. Twice natural size

It is small, reddish brown above and yellow beneath. Its legs are partly tinged with a bright red and its hind wings are colorless. It is found in considerable numbers throughout the entire United States, southern Canada, and northern Mexico.

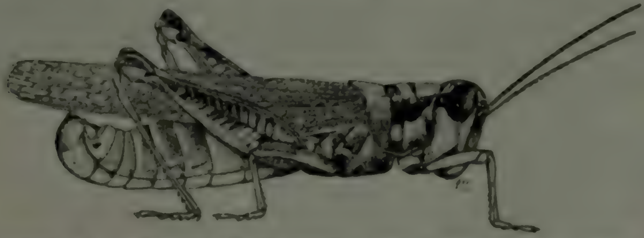


FIGURE 5.—Red-legged grasshopper. Adult male. Twice natural size

The Carolina grasshopper (*Dissosteira carolina* L.) (fig. 6) is of medium to rather large size, and is usually of a plain pepper-and-salt color, sometimes varying from gray through yellowish to a distinctly reddish color depending upon the soil upon which it is found. Its hind wings are nearly black, margined with yellow. Thus it is inconspicuous while sitting upon the ground but catches the eye immediately upon taking flight. It is very widely distributed throughout the entire United States.

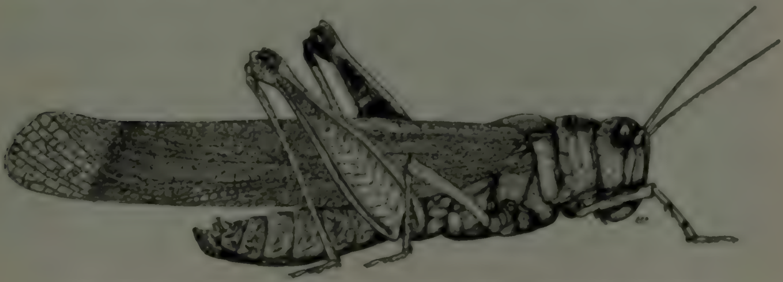


FIGURE 6.—Carolina grasshopper. Adult male. Twice natural size

The pellucid or clear-winged grasshopper (*Camnula pellucida* Scudd.) (fig. 7) is small and its hind, or true, wings are clear or pellucid while the front wings are distinctly blotched with brown. It is distributed throughout the Northern States from the Atlantic to the Pacific, and is at times one of the most injurious species in the United States.

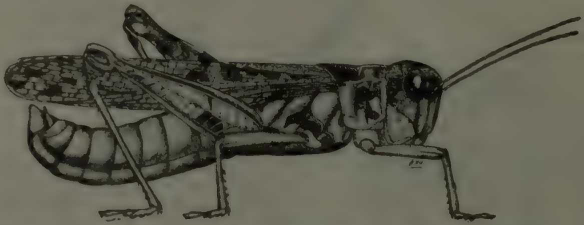


FIGURE 7.—Clear-winged grasshopper. Adult male. Twice natural size

Grasshoppers, both young and old, injure crops in but one way, by gnawing and devouring them wholesale. Where very numerous they have been known to consume almost every green thing in sight (fig. 8), even eating the bark on the tender twigs of trees and gnawing the handles of hoes and rakes in order to secure the salt left there by perspiring hands.

CONDITIONS FAVORABLE TO OUTBREAKS OF GRASSHOPPERS

It is generally believed that dry, warm weather is favorable for grasshoppers and it is known that the most severe outbreaks have occurred either during or following periods of drought. Wet weather is unfavorable and great numbers of grasshoppers often die from disease under such conditions. Many years ago, attempts were made to control grasshoppers by spreading disease among them, but it was found that both fungous and bacterial diseases developed of their own accord during wet weather but always failed to thrive under dry conditions. Cool weather during the egg-laying period decreases the number of eggs laid. Winter temperatures have little effect upon grasshopper abundance.

LIFE HISTORIES AND DEVELOPMENT OF GRASSHOPPERS IN GENERAL

The life histories of the various species of injurious grasshoppers are quite similar. The eggs are usually deposited in the soil, inclosed in sacs, or "pods," formed of a glutinous substance furnished by the female. The grasshopper thrusts her abdomen, which is capable of considerable extension, into the soil (fig. 3) and starts laying her eggs at the farther end of the tunnel thus formed, which is then filled with eggs and sealed. One grasshopper has been known to deposit as many as 441 eggs.

Egg laying usually takes place in late summer or early fall and the young grasshoppers emerge the following spring. In some of the Southern and Southwestern States the young grasshoppers may emerge as early as February, but in the North the eggs usually do not hatch until May or June.

In contrast to many other injurious insects, grasshoppers when newly hatched closely resemble their parents, except that they lack wings. There is no grublike larval stage, nor is there any resting or true pupal stage, such as that of butterflies and moths. The young grasshoppers are active and able to hop almost immediately upon

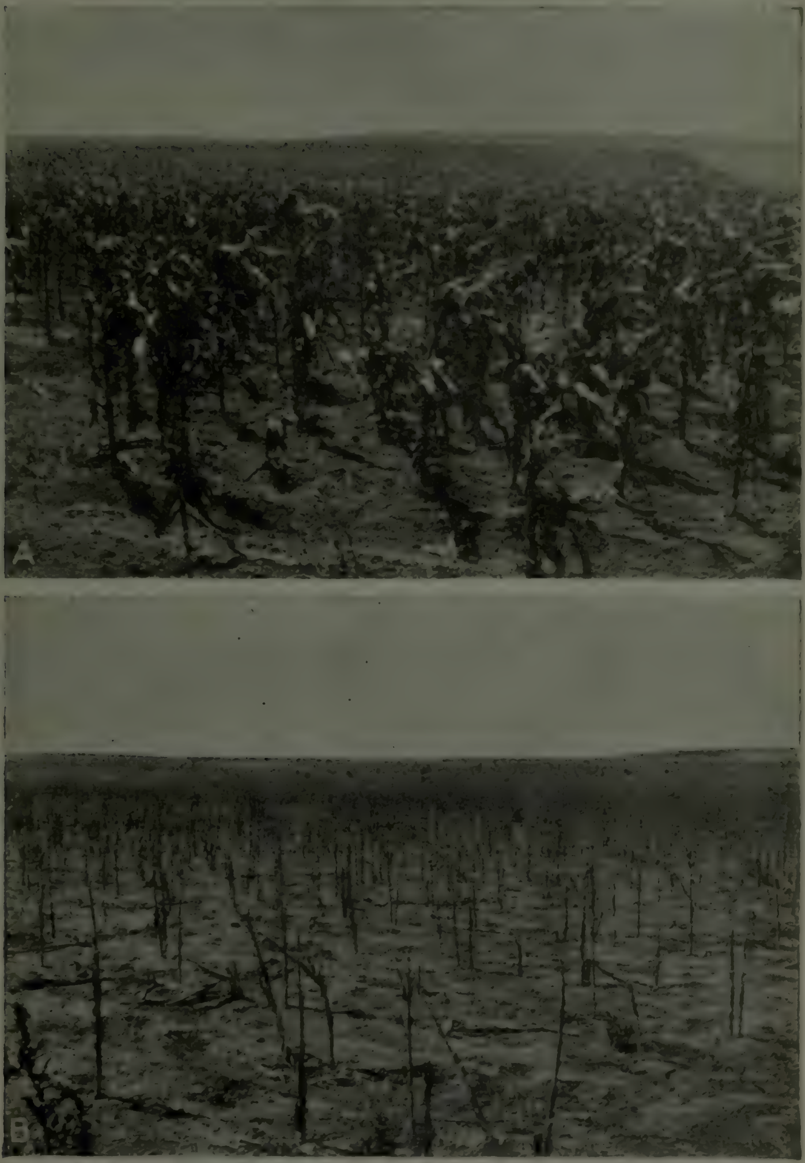


FIGURE 8.—These photographs show how grasshoppers may ruin corn. In the upper picture an army of adult differential and 2-striped grasshoppers is entering the corn at the edge of field shown in the foreground. The lower picture shows the same field a few days later after the grasshoppers have passed through it. In many cornfields in the immediate vicinity every stalk was devoured to the very ground

emergence from the eggs. They require from 40 to 60 days to grow into maturity and develop wings. During this time they shed their skins five or six times. The cast-off skins are often mistaken for dead grasshoppers and frequently are the basis of mistaken reports that grasshoppers are "dying by the millions." The appearance of wings, except in the wingless species, marks the final stage of growth, and the grasshopper is then ready to mate and reproduce. There is only one generation a year.

NATURAL ENEMIES

Several kinds of parasitic 2-winged flies deposit maggots upon grasshoppers in their mature or nearly mature stage. Among the most important of these is a flesh fly, which has been observed to deposit live maggots upon the grasshoppers while they are in flight. The maggot devours the internal portions of the grasshopper's body and soon causes its death. Robber flies feed very largely upon young grasshoppers, grasping them with their long, stout legs, thrusting their strong beaks through the body walls of the grasshoppers, and sucking out the liquid contents of the bodies. Several kinds of digger wasps kill or stupefy grasshoppers by stinging and then drag them into their underground nests. The wasp then lays an egg upon the body of the grasshopper, which subsequently becomes food for the newly hatched grub. A number of blister beetles are known to prey in their young stages upon the eggs of grasshoppers, but as the adult beetles are sometimes quite injurious to potatoes, beans, and other cultivated plants, they can not be considered as entirely beneficial.

The Bureau of Biological Survey has found that birds play an important part in the natural control of grasshoppers. All birds except the strictly vegetarian doves and pigeons feed on grasshoppers and destroy large numbers of them, but they can not be expected to prevent outbreaks. It has often been asserted that the reason grasshoppers are so abundant at the present time is that game birds are less numerous than formerly. It should be remembered, however, that the worst grasshopper outbreaks in the history of American agriculture occurred in the Great Plains region 50 to 60 years ago when game birds were far more plentiful than they now are.

CONTROL MEASURES

Two principal methods of control have been found to be of practical value in combating grasshoppers in this country: (1) Destruction of the eggs; and (2) use of poisoned baits.

DESTROYING GRASSHOPPER EGGS

Where grasshopper eggs are laid in ground that can be economically plowed or harrowed, great numbers of them can be destroyed by these operations. The lesser migratory grasshopper, when abundant, lays great numbers of eggs around the roots of the current year's grain crops. Plowing and packing the stubble fields either in the fall or early in the spring delays the hatching of the eggs and prevents the young grasshoppers from reaching the surface. The 2-striped and the differential grasshoppers most often lay their eggs in sod land and weedy ground around the edges of forage and cereal crops. Plowing or disking headlands and ditch banks may destroy great numbers of the eggs. The clear-winged grasshopper concentrates its eggs in overgrazed pastures, wild-hay meadows, and in sod land along roadsides. To plow or disk such land is expensive and ruins it for grass production. Under such conditions egg destruction becomes impractical.

When land that contains grasshopper eggs is plowed, the soil should be turned to a depth of at least 6 inches; it should then be harrowed or packed. If the job is well done, the young hoppers hatching from the eggs are not able to reach the surface. Cultivating with a disk harrow breaks open many of the egg pods and brings them to the surface, where they dry out and die. Several diskings about 10 days apart are necessary to bring most of the eggs to the surface. Disking during warm, dry weather in September and October is more effective than disking in the spring.

USING POISONED BAIT

Use of poisoned-bran mash has proved to be a simple, reliable, and cheap method of destroying grasshoppers. This mash has been applied with signal success in many portions of the United States.

MATERIALS RECOMMENDED

In obtaining a proper formula for the mixture many substances have been tried, and the following formula is now recommended:

Coarse bran	pounds	100
Crude arsenic	do	5
Cane molasses	gallons	1½
Water	do	10–12

Bran.—Coarse wheat bran should be used if possible. Bran containing shorts or flour should be avoided, as it causes the mash to gather in lumps which are very hard to break up and which, when scattered in the field, are unattractive to the grasshoppers and dangerous to livestock. The use of good coarse bran greatly reduces the labor of mixing and such bran should be insisted upon where large quantities are to be prepared.

Arsenic.—Finely powdered crude arsenic obtained from smelters is recommended. It is more bulky and more finely divided than the more expensive refined white arsenic and therefore mixes better with the bran. Two quarts of liquid sodium arsenite (4-pound material) or 2½ pounds of dry sodium arsenite can be substituted for the 5 pounds of crude arsenic in the formula. Paris green can also be substituted, but is much more expensive. Calcium arsenate, sodium arsenate, or lead arsenates should never be used.

Molasses.—Only the low-grade cane molasses known as blackstrap is cheap enough to warrant its use. Molasses from the grocery store purchased in gallon lots is usually too costly and is no more attractive than the cheaper grade. Beet molasses has been used with good results against the clear-winged grasshopper, but with different species it has acted as a repellent. It is therefore recommended for use only where the clear-winged grasshopper is dominant.

OTHER MATERIALS SOMETIMES ADDED TO THE BAIT

Amyl acetate.—This material is a liquid with a banana-like odor and has been used at the rate of 3 ounces per 100 pounds of bran to replace the citrus fruits formerly recommended. It has been used to advantage when feeding conditions for the hoppers have been unfavorable.

Salt.—Cheap, granular dairy salt sometimes adds to the attractiveness of the bait. However, where the soil is alkaline it has proved to be a distinct repellent and is not recommended for general use.

Sawdust.—In some sections where its addition cheapens the bait, sawdust mixed in equal parts by weight with the bran has been used with good results. It has a tendency to cut down the effectiveness and should only be used if sufficient bran can not be obtained at a reasonable price.

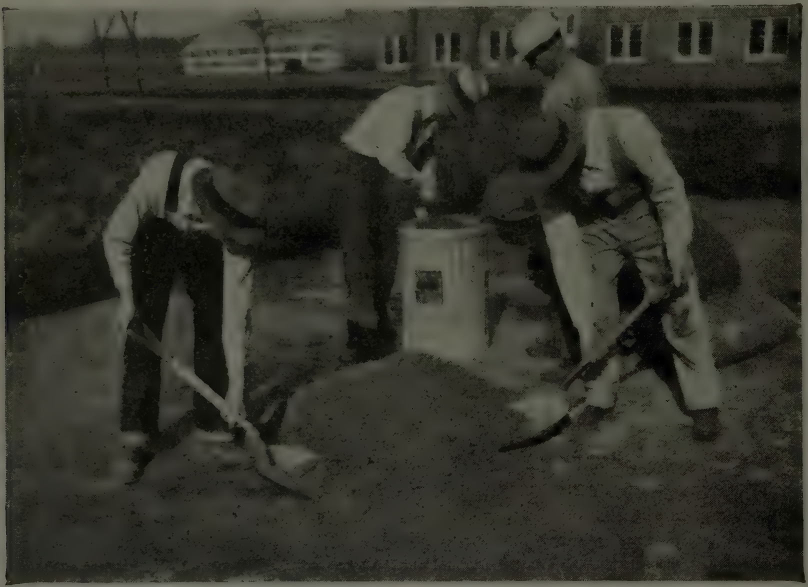


FIGURE 9.—Mixing poisoned-bran bait. The water, arsenic, and molasses are being mixed in the large can in the center of the picture[1]

Good results have been obtained by using a mixture of bran, arsenic, and water, and if it is not possible to obtain the molasses or other attractants it is far better to use the poisoned-bran mash without them than to delay until the crop has been seriously damaged.

MIXING THE BAIT

The bran is spread out on a tight floor or in a wagon box or similar container (fig. 9) to a depth of 8 to 10 inches. The required quantities of water, arsenic, and molasses are mixed thoroughly in a large can or barrel. This mixture is then splashed over the bran, about 3 gallons at a time, and the bran is worked into a mash by turning it over with a scoop shovel, potato fork, or garden rake. When either crude arsenic or Paris green is used, the liquid must be stirred constantly, as otherwise the poison soon settles out. Continuous stirring is not necessary when dry or liquid sodium arsenite is used, as this compound dissolves quickly in water. About 200 pounds of bran is all that can easily be mixed in a wagon box at one time, but on a floor where there is plenty of room about 500 pounds can be handled. Good results depend on mixing the mash thoroughly until it contains no lumps and is moist throughout. It should fall in flakes when scattered with the hand.

---

[1] Figures 9 and 10 were furnished by the courtesy of C. J. Drake of the Iowa Agricultural Experiment Station.

When amyl acetate is used, it should be added to the other wet ingredients before the mixture is poured over the bran.

CAUTION

Poisoned-bran mash scattered in flakes will never be picked up by livestock in sufficient quantity to cause trouble, but if it falls in lumps animals may eat it with disastrous results. Farm animals have been poisoned by uncovering and eating left-over grasshopper bait that had been buried months before, in straw stacks and in the ground. Unused poisoned-bran mash should either be scattered thinly and evenly over the ground or burned in a stove or furnace. Barrels that have contained arsenic should also be burned. Great care should be taken in handling arsenic. Continued breathing of arsenic dust may seriously injure the lungs and if allowed to remain on the skin the dust may cause painful burns. Commercially mixed poisoned bran should be labeled "POISON," and every precaution taken to see that it is not accidentally fed to livestock in place of ordinary bran. It should never be left on wagons or trucks where horses or cattle can break open or lick the sacks containing it, and it should be stored in a building inaccessible to livestock and small children.

COMMERCIAL BAIT

Several commercial mixtures for the control of grasshoppers have been put on the market and are all right when honestly made. One commercial preparation is molasses and sodium arsenite already mixed in the proportion of 2 gallons of cane molasses to 2 quarts of sodium arsenite (4-pound material). Two and one-half gallons of this mixture added to 10 or 12 gallons of water is sufficient for 100 pounds of bran. Another mixture contains 80 pounds of bran, 15 pounds of cane molasses, and 5 pounds of crude arsenic mixed in stock-feed mills. The bran and arsenic are first mixed and then the hot molasses is added and the whole is thoroughly milled. The user has only to add water.

The advantages of the commercial over the home-mixed bait are that a much better mixture is obtained, dangers in the handling of arsenic by inexperienced persons are eliminated, and the product can be purchased ready-made from one concern, rather than assembled from several sources. This avoids delays which often prove disastrous.

Commercial baits should have at least the arsenic content required by the formula recommended in this bulletin.

METHODS OF DISTRIBUTION

The prepared mash should be thinly and evenly scattered over infested fields at the rate of 10 to 20 pounds (dry weight) per acre, according to the number of grasshoppers present. It is most commonly spread by hand. Every precaution should be taken to see that it falls apart into flakes. Casting it into the wind with a snap of the wrist will help to accomplish this. When large quantities of mash are to be distributed, scattering from the rear end of a wagon or truck is recommended. (Fig. 10.) This method permits two men to scatter at one time as the vehicle is driven slowly over the field. An end-gate seeder can be used, but must be carefully watched and not allowed to clog because of too rapid feeding. When large, uniformly infested areas difficult of access by wagon or truck are to be treated, scattering by airplane seems to be practicable. This is done by feeding the mash into the backwash from the propeller. From 75 to 100 acres per hour can be treated at an average cost of 10 to 15 cents per acre for use of the plane. The cost of scattering from wagons or trucks ranges from 10 to 20 cents per acre according to local conditions.

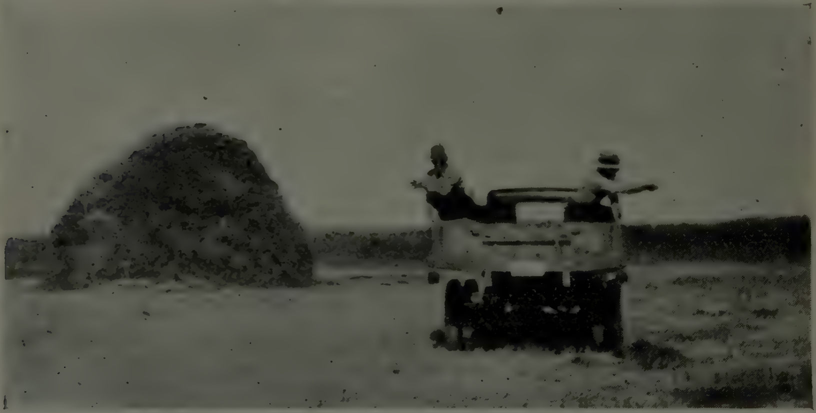


FIGURE 10.—Scattering poisoned bait from rear end of auto truck

TIME OF DISTRIBUTING BAIT

The poisoned bait should be put out while the grasshoppers are on the ground, doing their first feeding of the day. This occurs as soon after sunrise as the temperature of the air reaches 70° to 80° F., usually between 6 and 10 o'clock in the morning. Exact temperatures at which maximum feeding occurs differ with the locality and the species. The bait should not be put out when the temperature is below 70° or above 85° F., or during cloudy or inclement weather. An exception to this rule can be made with grasshoppers that are migrating. Under such conditions they feed greedily on poisoned-bran mash scattered across the line of march, regardless of time and temperature.

Newly hatched grasshoppers usually remain for some time congregated on their hatching grounds. They should be poisoned while they are still confined to these places or before they have invaded crops. It is important to realize that the use of poisoned bran is far more effective when young grasshoppers are concentrated along headlands than after they have increased in size and are dispersed over an entire field. Fighting grasshoppers before they attack or at the time they are first invading crops is one essential of a successful control campaign.

Grasshoppers do not die immediately after they have eaten the poisoned bait. The poison may require 24 hours or even longer to become fully effective. It usually makes grasshoppers sick within a few hours, however, and they do little damage after having eaten a fatal dose.

ADDITIONAL SUGGESTIONS FOR CONTROL

BARRIER STRIPS

When young grasshoppers are hatching in sod land adjacent to a crop likely to be attacked, their advance into the crop can be retarded by plowing a strip between the field and the sod land. If several deep furrows with sharp sides are plowed, the young hoppers will gather in them and can be killed by daily application of poisoned-bran mash.

TRAP STRIPS

Grasshoppers frequently are very abundant in alfalfa and other hay crops at the time of the first cutting. If narrow strips of such crops around the edges of the field and along irrigation ditches are left uncut, grasshoppers from all over the field will gather in them, and can be easily poisoned.

BURNING

At night, and even in the daytime during cool weather, grasshoppers seek protection. At such times great numbers of them can often be killed by scattering straw or weeds where the grasshoppers are congregated in the late afternoon and burning it at night after they have crawled into it and become sluggish.

POULTRY

Flocks of turkeys or chickens eat great numbers of grasshoppers and can sometimes be used to advantage in small local outbreaks.

CATCHING MACHINES

Various kinds of grasshopper-catching machines (fig. 11) have been largely used in the past, but they are no longer recommended unless it is desired to save the grasshoppers for poultry food or fish bait. The poisoned-bran mash is far more effective and is cheaper.

IMMUNE CROPS

Some of the sorghums, such as cane and Kafir corn, after reaching a height of 8 to 10 inches are practically immune to grasshopper attacks. They can be planted rather late in the season and provide valuable feed for livestock in areas where control measures have not been applied in time to save other forage crops.

ORGANIZING FOR GRASSHOPPER CONTROL

Where grasshoppers originate on a particular farm and menace only the crops on that farm, individual action is sufficient. If, however, they are present in such numbers that they are likely to move from one farm to another, community and often county-wide action becomes necessary. This can be secured only through proper organization, effective leadership, and adequate financial backing. Lacking any one of these essentials, a large-scale grasshopper campaign can not be successful. Unless a suitable organization already exists, one should be started. It may well be a farm bureau, farmers' union, community club, or other farmers' organization, headed by an active, efficient chairman. The following type of county organization is suggested:

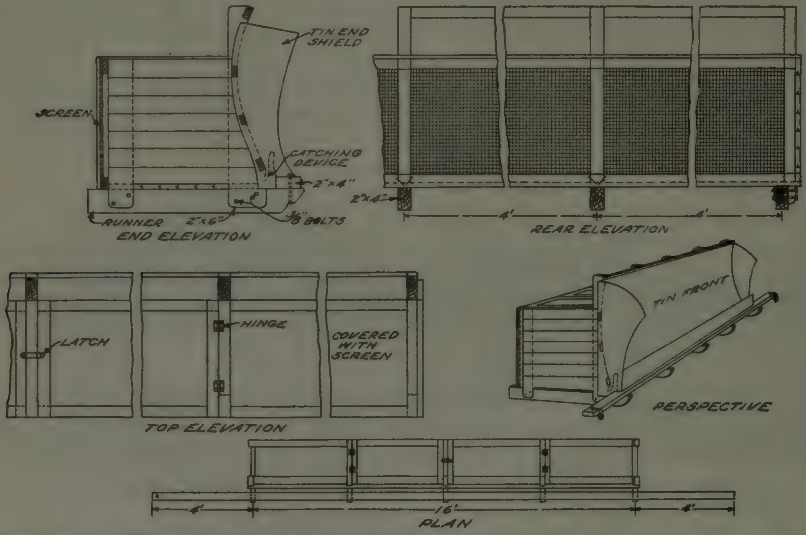


FIGURE 11.—Where it is desired to catch a quantity of grasshoppers to be used as poultry food, the grasshopper catcher is useful. Such a machine may be constructed according to the details shown in this illustration

(1) One executive, the county agricultural agent, if there is one, should be in charge of the campaign for the county. He should be responsible for funds expended, should purchase and apportion supplies, instruct community leaders in the methods to be employed, and make contact with State entomological leaders in order to obtain the latest information on grasshopper control.

(2) There should be community or township chairmen to act as supervisors under the direction of the county leader.

(3) Under these community chairmen there should be foremen of mixing and distributing centers to receive materials, to oversee mixing of materials, and to check out mixed materials to individual farmers and scattering crews.

(4) Finally, captains of scattering crews, men well acquainted with grasshopper conditions and familiar with the correct method of scattering poisoned-bran mash, should supervise the crews of men who scatter the bait in the field.

Farmers should cooperate and poison all grasshoppers regardless of where they are found. Cleaning up an entire community or township will not only save current crops but will render control measures the following year unnecessary. It should be emphasized that this is not a mere visionary ideal that can never be reached, but is an objective that has frequently been attained. A well-planned campaign, started early and pushed to completion before the grasshoppers are winged, will in most cases prevent serious crop losses; but if action is delayed in order to see what is going to happen or until the grasshoppers are doing serious damage and flying from one field to another, failure is certain.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	Arthur M. Hyde.
Assistant Secretary	R. W. Dunlap.
Director of Scientific Work	A. F. Woods.
Director of Regulatory Work	Walter G. Campbell.
Director of Extension Work	C. W. Warburton.
Director of Personnel and Business Administration.	W. W. Stockberger.
Director of Information	M. S. Eisenhower.
Solicitor	E. L. Marshall.
Weather Bureau	Charles F. Marvin, *Chief.*
Bureau of Animal Industry	John R. Mohler, *Chief.*
Bureau of Dairy Industry	O. E. Reed, *Chief.*
Bureau of Plant Industry	William A. Taylor, *Chief.*
Forest Service	R. Y. Stuart, *Chief.*
Bureau of Chemistry and Soils	H. G. Knight, *Chief.*
Bureau of Entomology	C. L. Marlatt, *Chief.*
Bureau of Biological Survey	Paul G. Redington, *Chief.*
Bureau of Public Roads	Thomas H. MacDonald, *Chief.*
Bureau of Agricultural Engineering	S. H. McCrory, *Chief.*
Bureau of Agricultural Economics	Nils A. Olsen, *Chief.*
Bureau of Home Economics	Louise Stanley, *Chief.*
Plant Quarantine and Control Administration	Lee A. Strong, *Chief.*
Grain Futures Administration	J. W. T. Duvel, *Chief.*
Food and Drug Administration	Walter G. Campbell, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	James T. Jardine, *Chief.*
Office of Cooperative Extension Work	C. B. Smith, *Chief.*
Library	Claribel R. Barnett, *Librarian.*

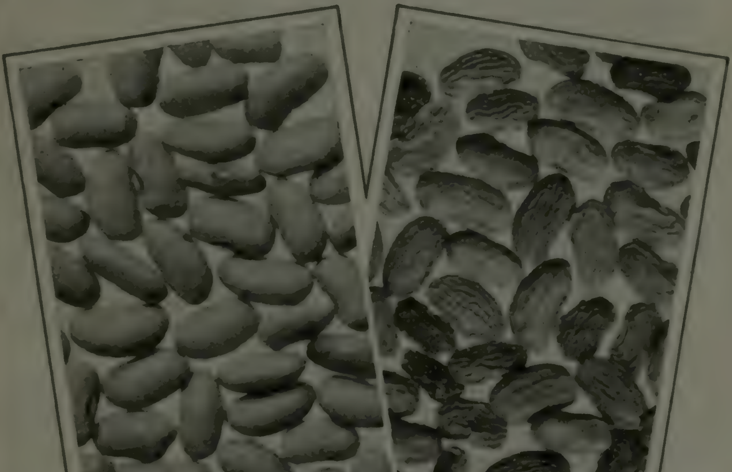
U. S. GOVERNMENT PRINTING OFFICE: 1932

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1692

BEAN DISEASES and THEIR CONTROL



1862 1889

BEANS are subject to a number of diseases that cause injury and loss. The purpose of this bulletin is to describe these diseases briefly, so that they can be identified by the grower, and to give recommendations for preventing and checking them.

Anthracnose is a seed-borne disease. To control it, use seed grown in regions where it does not occur. Such seed is grown in Colorado and the States west. Practice a crop rotation of three or four years when possible.

Bacterial blight is also seed borne, and the control measures are the same as for anthracnose. Seed grown in the western part of the United States carries less infection than eastern-grown seed.

Mosaic is likewise seed borne. No satisfactory means of control are known. It is advisable to plant mosaic-free seed when it is obtainable. Where mosaic limits successful growing, use resistant varieties.

No control for rust is known. Planting immune or highly resistant varieties is recommended.

Powdery mildew can be controlled by one or two dustings with powdered sulphur, the first to be applied as soon as there is any evidence of disease, and the second, if necessary, one to two weeks later.

No satisfactory control for root rots is known. Rotation of three or four years with such crops as corn, oats, rye, and alfalfa, and maintaining the highest degree of tilth of the soil, help to reduce the loss. Breeding resistant varieties is about the only permanent solution of the problem.

To control root knot, caused by parasitic eelworms, plant immune crops and practice crop rotation.

No control for yeast spot of Lima beans is known.

The pod blight and downy mildew of Lima beans are seed borne. The causal organisms also live over winter on dead plant parts left in the field. When possible burn the old vines and pods. These diseases do not occur in the West, where most of the Lima-bean seed is grown. It is advisable to procure western-grown seed rather than to save seed from a previous crop. A 4-4-50 Bordeaux spray might help to check the diseases, although its use is not generally recommended.

Washington, D. C. **Issued July, 1932**

BEAN DISEASES AND THEIR CONTROL

By L. L. HARTER, *Senior Pathologist*, and W. J. ZAUMEYER, *Associate Pathologist, Division of Horticultural Crops and Diseases, Bureau of Plant Industry*

CONTENTS

Page
The bean industry and losses from disease 1
Diseases of garden and field beans 2
  Anthracnose 2
  Bacterial blight 5
  Mosaic (curly leaf) 9
  Rust 12
  Root rots 15
  Root knot 17
  Curly top 18
  Baldhead (snakehead) 19
  Powdery mildew 20
  Ashy stem blight 21
Diseases of garden and field beans—Continued.
  Sun scald 22
  Angular leaf spot 23
Diseases of Lima beans 23
  Downy mildew 23
  Pod blight 24
  Bacterial spot 25
  Yeast spot 26
  Baldhead (snakehead) 27
  Ashy stem blight 27
Diseases of garden and Lima beans found in transit 27

THE BEAN INDUSTRY AND LOSSES FROM DISEASE

BEANS are important in the diet of a large portion of the world's population. They are grown in practically every part of the United States. Most farmers and many urban home gardeners grow them for home use. The commercial bean industry in the United States has grown to large proportions. Those engaged in it may be divided roughly into four groups: (1) The market gardeners, who grow beans for consumption as a green vegetable; (2) the growers of dry shelled beans; (3) the seed growers; and (4) the canners.

The market gardening of green beans is carried on by a large number of farmers along the Atlantic seaboard from the South into the North, along the Pacific coast, and to a lesser extent throughout the Central States. The culture is now so widely distributed that green beans are available most of the year in many parts of the country. Dry shelled beans are not quite so generally grown, but occupy far greater acreage and are produced in much greater volume. The bulk of the dry shelled beans is grown in a few Northern and Western States. The seed-growing industry is restricted mainly to varieties of garden and Lima beans and is centered in a few Northern and Western States. It is largely in the hands of a comparatively small number of firms, although a considerable number of farmers grow seed for the commercial concerns. Commercial canning of green beans has increased materially in recent years and is carried on in many States. A large number of farmers grow beans for the canners. Since 1922 the canning business has sprung up in new territory, but the largest volume of production is in New York, Maryland, and Wisconsin.

Regardless of the type of bean production followed or of where the crop is grown, certain diseases are prevalent. Bean diseases are not restricted to varieties grown by any one or more groups, but are limited only by climatic conditions. They cause serious damage and loss in various ways: By killing seedlings; by injuring or killing the growing plants; or by spotting and decaying the pods and seeds and thus lowering the yield and rendering much of the product unmarketable. Under conditions especially favorable for the development of disease the losses may be very heavy. The disease problem is therefore a serious hazard.

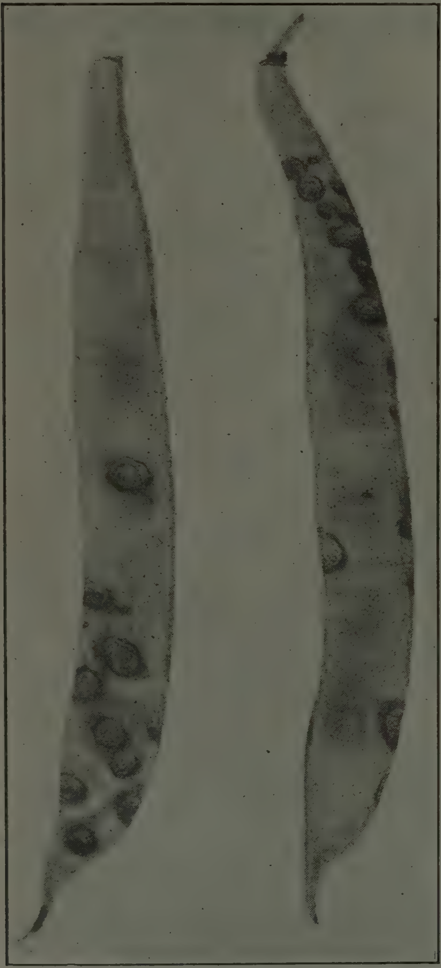


FIGURE 1.—Bean anthracnose on the pod. The roundish, sunken cankers contain myriads of spores, which may be carried to other pods or to the leaves and start new lesions

This bulletin gives brief descriptions of the various diseases, information on their causes, and recommendations for their prevention and control. Unfortunately, in some cases no control measures are known.

DISEASES OF GARDEN AND FIELD BEANS

ANTHRACNOSE

DESCRIPTION

Bean anthracnose is of major importance to growers in the Eastern and Southern States, since in certain years when conditions are favorable the disease may be so widespread that it renders entire fields practically worthless. It may not only kill the seedlings, but it often infects older plants badly, and spots the pods so severely (fig. 1) that they are unfit for consumption. Anthracnose may occur on any part of the plant above ground during almost any stage of its life.

Infected seed (fig. 2) is characterized by dark sunken lesions of different sizes which may extend just through the seed coat and penetrate the cotyledons. Spores form in these lesions, which are sources of infection of the stem and young leaves, which in turn may become sources of infection for the older leaves and pods. The oval cankers on the stem are sunken and range from brown to nearly black in color, with a somewhat purplish to brick-red border, the long axis of the canker extending up and down the stem. The fungus may so weaken the stem that it is easily broken in cultivating or by a strong wind.

Anthracnose generally follows the veins on the underside of the leaves, causing them to become dark purplish to dark red. These streaks may be found on most of the veins of a leaf or on only a few in isolated regions. In severe attacks dead angular spots show on the upper surface of the leaves, giving them a ragged appearance.

It is on the pods, however, that the disease is most conspicuous. It begins as minute, reddish-brown, elongated spots which are often oblique to the long axis of the pod. These spots, often quite numerous, gradually become more or less circular and sunken at the center, surrounded by a rusty to brown-colored border. The spots may be one-fourth of an inch or more in diameter when mature. During moist weather numerous spores are produced within the cankers, and give them a somewhat pinkish color. When the pods are picked it is sometimes not easy to detect very young lesions, but under suitable conditions they may develop into conspicuous cankers in a few days. These cankers frequently extend entirely through the walls of the pod and often into the seed, where the disease organism may live buried beneath the seed coat for many months. The new crop becomes diseased principally through infected seed.

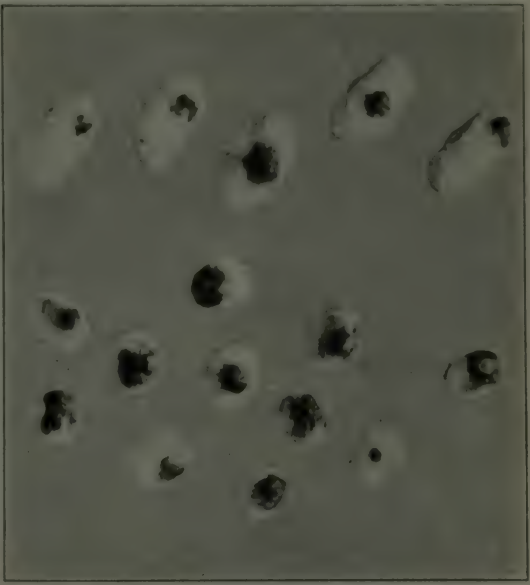


FIGURE 2.—Bean anthracnose on the seed. The seed is infected through the cankers on the pods. Infected seed serves as a means of infecting the new crop and should never be planted

CAUSE

Anthracnose is caused by a fungous parasite, *Colletotrichum lindemuthianum* (Sacc. and Magn.) Briosi and Cav., which attacks beans and a few other related plants. The pinkish centers of the cankers are composed of myriads of spores, or seedlike bodies, which are disseminated by various means to other plants and plant parts, where a new infection is established. These spores are also found to a less extent in the lesions on the leaves, petioles, and stems.

Wind and rain are probably the two principal agencies in disseminating the spores, which, however, may also be carried on the bodies of insects, on the hands of laborers picking beans, on farming implements, and by various other mechanical means. The spores are embedded in a sticky substance which readily adheres to whatever it touches. For this reason it is not advisable to enter bean fields to pick or cultivate the beans when the foliage is wet.

Anthracnose may be carried over from one season to the next on old vines in the field and by means of infected seed. It is not known just how long the spores will survive under field conditions, but experiments indicate that they remain viable at least two years.

CONTROL

The control of anthracnose by spraying and dusting with fungicides has not been especially effective, and until more information about their use is available they are not recommended.

Crop rotation is a good practice even if not necessary for the control of plant diseases. Since bean anthracnose is known to survive two and possibly three years in the field on the débris of previous crops it is advisable to practice a rotation that will not bring beans on the same ground oftener than once every third or fourth year.

Bean anthracnose is a seed-borne disease. During the growing season in regions where the disease occurs and cankers develop on the pod, the fungus often grows entirely through the pod and enters the seed, where it may remain alive for months and possibly for years. When such seed is planted and germination begins, the fungus likewise starts to grow, forming lesions on the cotyledons, from which later infections on the stem, petioles, leaves, and pods may arise. Inasmuch as the seed is the most effective means of disseminating the disease, it is highly important that only disease-free seed should be planted. Such seed can be obtained with certainty only from regions where anthracnose does not occur.

Beans are grown in most parts of the United States, and seed beans of the garden varieties are grown in a number of isolated regions in the East, in the Intermountain States, and along the Pacific coast. Anthracnose is very sensitive to changes in temperature and humidity and develops most abundantly in cool, wet weather, and largely disappears under hot, dry conditions. This fact explains why the disease is present in the East to some extent each year, while in the arid West it is seldom if ever found. Beans grown in Colorado and all of the other States farther west are free from the disease. Wherever possible seed from such regions should be used where anthracnose-free seed is desired.

Anthracnose occurs on practically all varieties of garden beans and on most of the dry shelled field sorts. In a few varieties of field beans, such as the Wells Red Kidney, White Imperial, and Perry Marrow, strains that are resistant to anthracnose have been developed. Those varieties are grown to only a limited extent in a few localities in the United States. Most of the more popular field varieties are quite susceptible to anthracnose.

BACTERIAL BLIGHT

DESCRIPTION

While bacterial blight of beans is caused by two distinct organisms, the symptoms produced by the two are so similar that one description will answer. Probably the most striking evidence of these diseases is noted on the leaves where the lesions first appear on the underside as small water-soaked spots. As these develop, a slight incrustation of dried bacterial ooze can be seen in their centers, surrounded by a yellowish zone resembling a halo. Different lesions

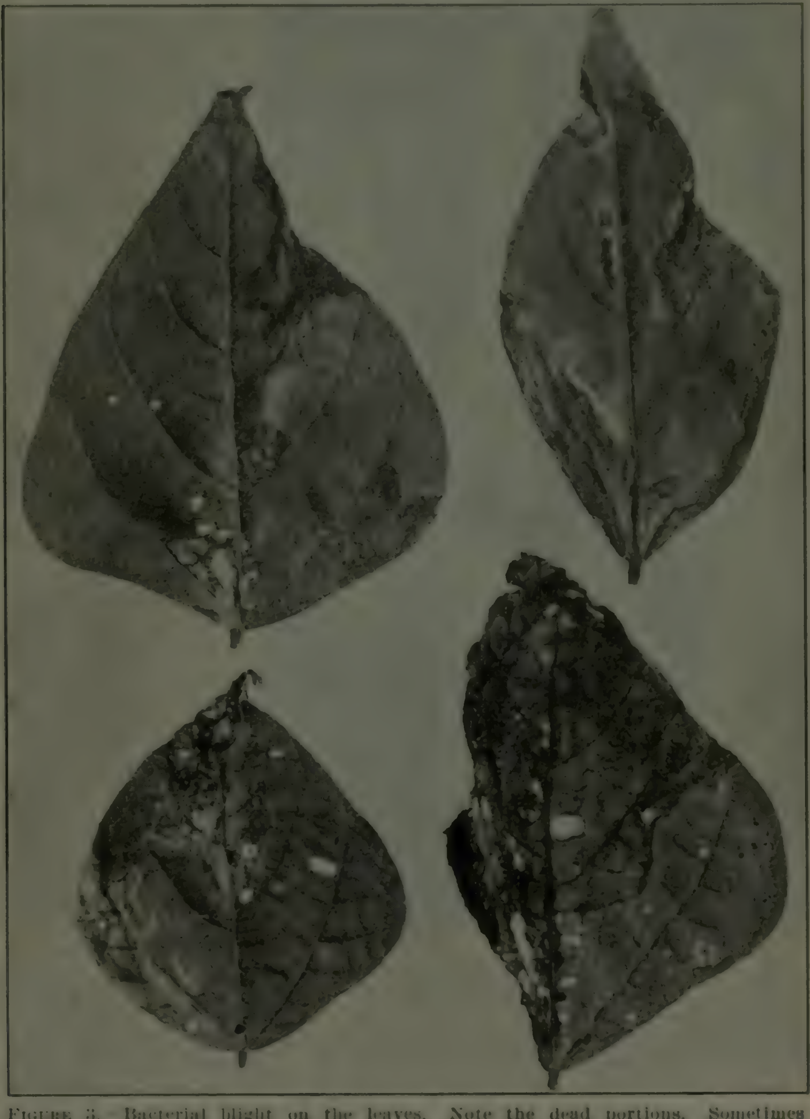


FIGURE 3. Bacterial blight on the leaves. Note the dead portions. Sometimes the injury is so extensive that growth of the plant is almost entirely stopped

may gradually merge, producing a brown, dead area (fig. 3), and in time causing defoliation of the plant.

The bacteria may cause one or another type of lesion on the stem. On the young seedling the diseased area starts as a small water-soaked spot which gradually enlarges and later takes on a reddish coloration. On the older stems the lesions appear as reddish dashes extending lengthwise along the stem.

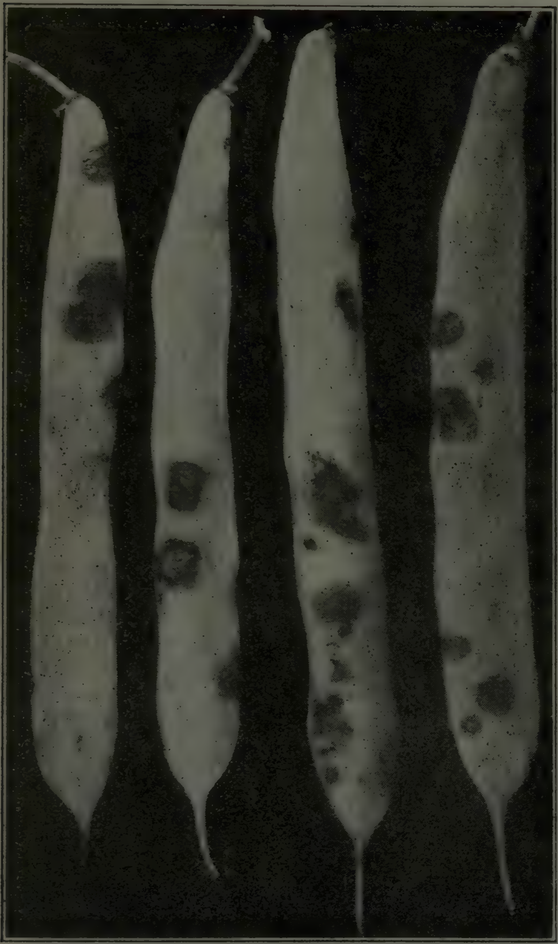


FIGURE 4.—Bacterial blight on the pods, showing reddish, water-soaked, irregularly shaped, slightly sunken spots. The seed may be invaded and serve as a source of infection for the new crop. Blighted seed should never be planted

When the plants are in the earliest stage of pod formation a characteristic lesion known as stem girdle or joint rot often appears. The lesions start at the nodes of the plant as small water-soaked areas and, as they enlarge, encircle the stem. Later these diseased regions become amber colored. The girdling is usually completed when the pods are half mature, and the affected stem is further weakened by the increasing weight of the top, so that it often breaks at the diseased node.

The disease causes much damage to the pods. (Fig. 4.) The bacterial spots start as minute water-soaked areas which become larger, and a discoloration with a distinct zoning follows this growth. Later the spots become dry and sunken and take on a brick-red color. Often a dried mass of bacterial slime can be seen covering the lesions.

The bacteria may also infect the upper hinge or suture of the pod, causing discoloration of this region and water-soaking of the surrounding tissue. Through this region the organism may attack the seeds, producing several types of lesion. When infection occurs while the pods are young, the seeds may rot completely, or become so severely infected that only the shriveled seed coats remain, or the bacteria may enter and discolor the hilum (the point of attachment of the seed to the pod). These lesions are difficult to detect in the case of slight infection, but with severe infection they cover a considerable area and produce a varnishlike appearance. On seed of light-colored varieties the symptoms are conspicuously manifested, but on dark-colored seeds they are easily overlooked.

When badly diseased seeds are planted, the seedlings may not push through the ground at all, or may be stunted and dwarfed. Some seedlings may grow to considerable size, but close examination usually reveals a lesion at the node where the cotyledons were attacked. This develops later into the stem girdle and usually results in the plant's breaking over at the time of pod formation.

CAUSE

The two organisms (*Bacterium phaseoli* E. F. Smith and *Bact. medicaginis* var. *phaseolicola* (Burkh.) Link and Hull) that cause bacterial blight produce symptoms that are difficult to differentiate. At times these causal organisms may be systemic; that is, they may traverse the plant through the water-carrying vessels or ducts without producing any external lesions. The seeds may become infected in this manner. When such seed, which apparently is healthy, is planted, the bacteria enter the young seedlings and produce disease in the plants.

Ordinarily the disease does not cause severe damage in the field until weather conditions favorable for the spread and development of the organisms prevail. The disease is favored by high temperatures in conjunction with heavy dews and rains. The bacteria may enter the stomata (breathing pores) of the leaves, stems, and pods, such penetration being favored by periods of rain or damp weather.

Blight may occasionally occur in regions of relatively low humidity. Under such conditions the organism does not react as it does in sections of high humidity. The most important symptom appearing under such conditions is stem girdle. Here, the organism is carried over in the seed and gradually infects the interior of the plant, working in the water ducts. Outside influences have little effect on the organisms, since there is sufficient moisture within the plant to allow them to develop. When the bacteria have increased to sufficiently large numbers, the plant becomes so weak that it is readily broken over and dies, without much secondary spread of the organism. This usually takes place at a time when the plant has developed to considerable size.

CONTROL

The methods of control recommended for anthracnose are largely applicable to bacterial blight. Treating diseased seed with chemicals has thus far met with but little success. Since the organism is carried beneath the seed coat, it is extremely difficult to kill it without injuring the seed itself.

Since blight may live over in the soil, it is unwise to plant beans on the same ground for more than one year, especially if the previous crop was diseased. Lima beans, soybeans, cowpeas, and similar legumes should not be used in the rotation, because they also may be hosts of the bean-blight organisms.

There are no bean varieties that are immune to bacterial blight, although not all varieties are equally susceptible to the disease, a few exhibiting a high degree of resistance. Table 1 shows the relative susceptibility and resistance to bacterial blight of some of the more common varieties of garden and field beans.

TABLE 1.—*Bean varieties grouped according to relative resistance and susceptibility to bacterial blight*

FAIRLY RESISTANT

Type and variety	Class	Kind of pod
Dwarf:		
Late Stringless Green Refugee	Garden	Green.
Refugee 1000–1	do	Do.
Refugee Wax	do	Wax.
White Imperial	Field	Green.
Pole:		
London Horticultural	Garden	Do.
Worcester Mammoth	do	Do.
MODERATELY SUSCEPTIBLE		
Dwarf:		
Blue Pod Small White	Field	Green.
Burpee Brittle Wax	Garden	Wax.
Burpee Stringless Green Pod	do	Green.
Burpee White Seeded Wax	do	Wax.
Early Wonder	Field	Do.
Extra Early Refugee	Garden	Green.
French Horticultural	do	Do.
Great Northern	Field	Do.
Giant Stringless Green Pod	Garden	Do.
Improved Kidney Wax	do	Wax.
Improved Black Wax	do	Do.
Keeney Rustless Wax	do	Do.
Robust	Field	Green.
Round Pod Kidney Wax	Garden	Wax.
Unrivaled Wax	do	Do.
Pole:		
Creaseback	do	Green.
Cutshort	do	Do.
Golden Cluster Wax	do	Wax.
Kentucky Wonder Wax	do	Do.
Lazy Wife	do	Green.
McCaslan Pole	do	Do.
VERY SUSCEPTIBLE		
Dwarf:		
Boston Pea	Field	Green.
Bountiful	Garden	Do.
Black Valentine	do	Do.
Blue Pod Navy	Field	Do.
Currie Rust Proof Wax	Garden	Wax.
Davis White Wax	do	Do.
Dwarf Horticultural	do	Green.
Dwarf White Navy	Field	Do.
Early Navy	do	Do.
Full Measure	Garden	Do.
Hodson Wax	do	Wax.
Improved Golden Wax	do	Do.
Improved Navy	Field	Green
Low Champion Bush	Garden	Do.
Navy Pea	Field	Do.
Pea Bean	do	Do.
Pencil Pod Black Wax	Garden	Wax.
Pilot Navy	Field	Green.
Red Kidney	do	Do.
Red Valentine	Garden	Do.
Small White Navy	Field	Do.
Sure Crop Wax	Garden	Wax.
Tennessee Green Pod	do	Green.
Wardwell Wax	do	Wax.
White Navy	Field	Green.
White Kidney	do	Do.
Pole:		
Case Knife	do	Do.
Kentucky Wonder	Field and garden	Do.

The use of clean seed is probably the most important recommendation that can be made for the control of bacterial blight. When such seed is planted, the amount of secondary spread of blight will be appreciably reduced, since the centers of infection will have been eliminated. Disease-free seed can be grown with certainty only in localities where blight does not develop because of unfavorable climatic conditions. While blight does not occur every year in regions where it is frequently found, there is no way of predicting when it will occur. For this reason it is best not to attempt to grow seed in regions subject to yearly epidemics of blight.

Blight occurs in varying amounts each year in all States east of the Rocky Mountains. In the intermountain region it may be present, but does not appear regularly, and when it does occur is usually less severe than in the Eastern States. Furthermore, in certain Western States (Idaho and California for example) it does not occur in amounts large enough to be of any concern; hence, seed produced in these regions is relatively free from disease and should produce a crop relatively free from blight.

Since all western-grown bean seed is not blight-free every year, it is desirable to determine the exact location in which the seed was grown. Purchasers of large quantities who desire only blight-free seed should ascertain the condition of the crop in the region where the seed originated. This is the only method by which they can be sure whether the seed is free from blight.

MOSAIC (CURLY LEAF)

DESCRIPTION

Bean mosaic, sometimes known as curly leaf, has been known for a long time, but not until recent years has it become wide-spread and destructive. It rarely kills bean plants, and slight infections do not produce conspicuous symptoms. This fact may explain why it is frequently overlooked by growers.

Bean mosaic, like the mosaic diseases of many other crops, stunts the plant and causes mottling and various types of leaf malformation. The symptoms differ slightly with the variety, age of plants, and somewhat with the conditions under which the plants are grown. Leaves affected with mosaic usually have irregularly shaped light-yellow and green areas (fig. 5) of various sizes, a type of mottling characteristic of mosaic in general. This may be the only evidence of the disease. In addition to the characteristic mottling, however, there may be considerable puckering, malformation, and other alterations in the shape of the leaf. Mosaic-affected bean leaves may be narrower and longer than normal leaves, with considerable downward cupping of the leaf due to the unequal growth of the leaf tissues. Bean plants attacked early in the season are usually yellowish in color, often dwarfed and spindling, and fail to produce a normal crop. Plants affected late in the season may produce almost a normal crop. The symptoms of the disease can not be recognized on the stems, pods, or seeds.

CAUSE

Bean mosaic is caused by a virus within the plant, the nature of which is not understood. If the leaves of a mosaic-affected plant are briskly rubbed against the leaves of a healthy plant so that the plant juices intermingle, mosaic symptoms will develop in the inoculated plant in from 7 to 15 days. It becomes yellowed and stunted and eventually exhibits all the symptoms of the plant from which the virus was taken. The mosaic-infected plant juice or virus may be carried throughout the entire plant and cause the seed to become infected, without producing any symptoms on the pod or seed. When planted, such seed, although appearing normal in all respects, may produce diseased plants. Not all the seeds of a mosaic-infected

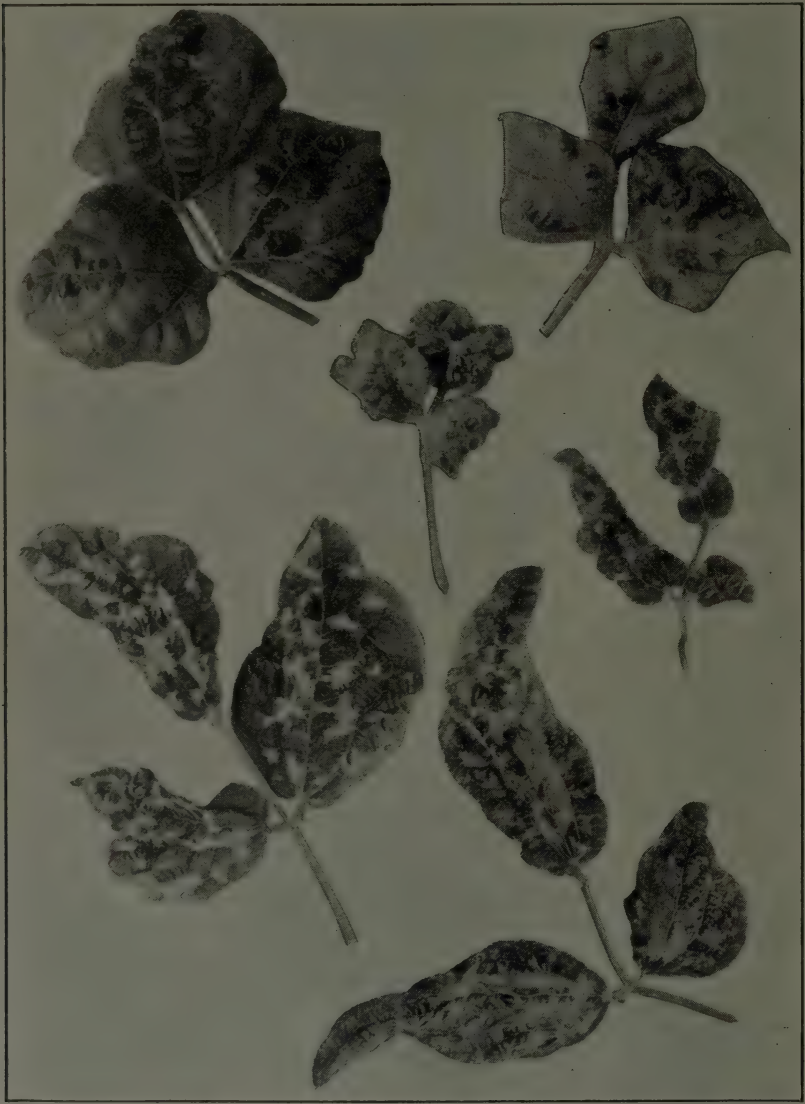


FIGURE 5.—Mosaic. Note the malformation of the leaves and the variation in their color, Mosaic is a seed-borne disease, and seed of affected plants should not be planted

plant carry the virus, but enough are infected to cause a considerable percentage of mosaic in the progeny. Some of the plants produced from such seeds are so stunted that they fail to develop to maturity. Others, slightly infected, may mature but produce diseased seed.

Under certain weather conditions the disease may not manifest itself even though the virus is in the plant. Because of this fact it is often difficult to diagnose the condition of certain infected plants. The same plants placed under different environment will exhibit decided mosaic symptoms. Infection is favored by reasonably high temperatures, while low temperatures tend to mask the symptoms.

CONTROL

No known treatment of the seed or plants is effective in controlling mosaic. The virus is so intimately associated with the seed itself that all attempts to kill it have also destroyed the seed. Inasmuch as the causal agency is carried in the seed, the use of disease-free seed and resistant varieties is recommended.

There are no varieties that show absolute immunity to mosaic. The best method of preventing the disease is by the introduction of seed stock from regions reasonably free from the malady. Because of the widespread distribution of the disease, it is somewhat improbable that seed absolutely mosaic free can be procured, although comparatively clean seed is produced along the Pacific coast. It is not good policy for growers to plant seed of unknown origin. It is advisable, in case of slight infection, to rogue out all suspicious plants as soon as they are seen, thereby reducing the chances of secondary spread.

Certain varieties of beans that show decided resistance to the disease may be grown where mosaic is very prevalent. While not entirely immune, they are infected so slightly that the disease does not cause an appreciable stunting of the plant or reduction in yield. Table 2 shows the relative susceptibility and resistance to mosaic of different varieties.

TABLE 2.—*Bean varieties grouped according to relative resistance and susceptibility to mosaic*

FAIRLY RESISTANT

Type and variety	Class	Kind of pod
Dwarf:		
Black Valentine	Garden	Green.
Bountiful	do	Do.
Burpee Brittle Wax	do	Wax.
Burpee Stringless Green Pod	do	Green.
Davis White Wax	do	Wax.
Dwarf White Navy	Field	Green.
Full Measure	Garden	Do.
Giant Stringless Green Pod	do	Do.
Improved Kidney Wax	do	Wax.
Pinto	Field	Green.
Robust	do	Do.
Round Pod Kidney Wax	Garden	Wax.
Unrivaled Wax	do	Do.
Pole:		
Creaseback	do	Green.
Kentucky Wonder	do	Do.
Kentucky Wonder Wax	do	Wax.
McCaslan Pole	do	Green

Table 2.—*Bean varieties grouped according to relative resistance and susceptibility to mosaic*—Continued

MODERATELY SUSCEPTIBLE

Dwarf:		
Blue Pod Small White	Field	Green.
California Red	do	Do.
California Pink	do	Do.
Currie Rust Proof Wax	Garden	Wax.
Dwarf Horticultural	do	Green.
Extra Early Refugee	do	Do.
French Horticultural	do	Do.
Genuine Small White	Field	Do.
Improved Black Wax	Garden	Wax.
Improved Golden Wax	do	Do.
Keeney Rustless Wax	do	Do.
Low Champion Bush	do	Green.
Pencil Pod Black Wax	do	Wax.
Red Kidney	Field	Green.
Sure Crop Wax	Garden	Wax.
Tennessee Green Pod	do	Green.
Wardwell Wax	do	Wax.
White Kidney	Field	Green.

VERY SUSCEPTIBLE

Dwarf:		
Blue Pod Navy	Field	Green.
Boston Pea	do	Do.
Burpee White Seeded Wax	Garden	Wax.
Early Navy	Field	Green.
Early Wonder	do	Do.
Great Northern	do	Do.
Hodson Wax	Garden	Wax.
Improved Navy	Field	Green.
Late Stringless Green Refugee	Garden	Do.
Navy Pea	Field	Do.
Pea Bean	do	Do.
Pilot Navy	do	Do.
Red Valentine	Garden	Do.
Refugee 1000–1	do	Do.
Refugee Wax	do	Wax.
Small White Navy	Field	Green.
White Imperial	do	Do.
White Navy	do	Do.
Pole:		
Cutshort	Garden	Do.
Golden Cluster Wax	do	Wax.
Lazy Wife	do	Green.
London Horticultural	do	Do.
Worcester Mammoth	do	Do.

RUST

DESCRIPTION

Rust of beans may occur on any aerial part of the plant, but is found most abundantly on the leaves. (Fig. 6.) Large unsightly pustules are sometimes found on the pods, petioles, and the tender parts of the stem. During the summer the pustules are reddish brown, circular, often with a secondary ring, and frequently surrounded by a zone of tissues yellowed by the loss of the green coloring matter. On the pods, petioles, and stems the lesions are large, more or less irregular in shape, and noticeably raised.

CAUSE

Bean rust is caused by a fungus (*Uromyces appendiculatus* (Pers.) Fries). Like similar organisms, it is propagated by means of spores. There are several stages in the development of this rust, but only two need be considered here. The red-rust stage occurs in the summer and is most important in the current season's distribution of the disease. These spores may germinate and cause infection as soon as they are mature. In a few weeks they are replaced by another type of spore with thick walls, which is capable of surviving the severe weather of winter. In the spring these winter spores germinate and under proper conditions for their spread and development they may cause infection, thus completing the life cycle of the fungus.

The occurrence and distribution of bean rust are closely correlated with atmospheric conditions. Rust is likely to occur in regions where cool nights and high humidities prevail. That is why the disease often occurs only in the latter part of the season, or in the fall. On the other hand, occasional epidemics in some of the western bean-growing regions (Colorado, for example) during the summer have been so severe that the entire crop was wiped out. Such epidemics, though occurring only rarely, can be definitely associated with weather conditions, such as cool nights accompanied by a period of damp, rainy weather, favorable to the disease.

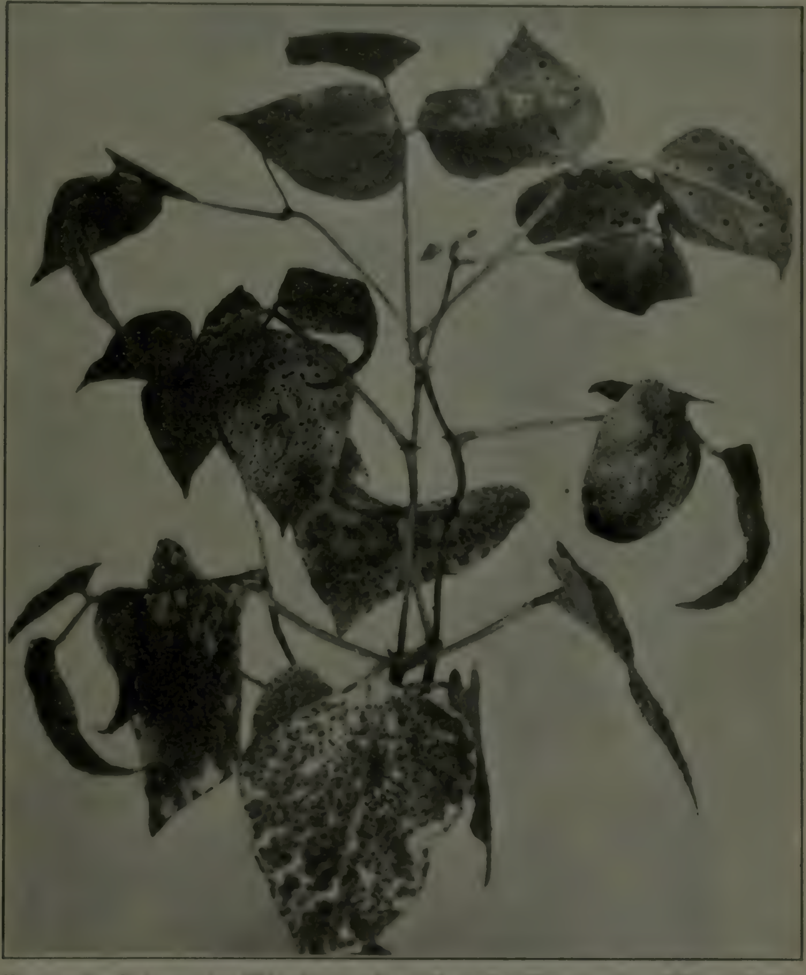


FIGURE 6.—Bean rust. This disease is very destructive to susceptible varieties during seasons favorable for its development. The pustules may develop on the leaves in numbers sufficient to defoliate the plants. Rust is not seed borne

CONTROL

No treatment of seed or plants is effective in controlling bean rust. The use of resistant varieties can be recommended. Unfortunately, a few of the best garden varieties and many of the dry-shelled or field varieties are very susceptible. Table 3 gives a partial list of the varieties that show a degree of resistance sufficient to justify their being planted in localities where the disease is a limiting factor. The table shows that there is considerable choice of resistant varieties in the garden group, while most of the field varieties are very susceptible, those showing some degree of resistance not being the ones most widely grown.

TABLE 3.—*Bean varieties grouped according to relative resistance and susceptibility to rust*

FAIRLY RESISTANT

Type and variety	Class	Kind of pod
Dwarf:		
Black Valentine	Garden	Green.
Bountiful	do	Do.
Burpee Brittle Wax	do	Wax.
Burpee Stringless Green Pod	do	Green.
Burpee White Seeded Wax	do	Wax.
Currie Rust Proof Wax	do	Do.
Cranberry	Field	Green.
Extra Early Refugee	Garden	Do.
Fordhook Favorite Bush	do	Do.
French Horticultural	do	Do.
Full Measure	do	Do.
Giant Stringless Green Pod	do	Do.
Hodson Wax	do	Wax.
Improved Kidney Wax	do	Do.
Improved Golden Wax	do	Do.
Improved Black Wax	do	Do.
Keeney Rustless Wax	do	Do.
Late Stringless Green Refugee	do	Green
Low Champion Bush	do	Do.
Pencil Pod Black Wax	do	Wax.
Refugee 1000-1	do	Green.
Refugee Wax	do	Wax.
Round Pod Kidney Wax	do	Do.
Rust Proof Golden Wax	do	Do.
Sure Crop Wax	do	Do.
Wardwell Wax	do	Do.
Pole:		
King Mammoth Horticultural	do	Green.
Lazy Wife	do	Do.

MODERATELY SUSCEPTIBLE

Dwarf:		
Bayo	Field	Green.
Canadian Wonder	Garden	Do.
Large White Marrow	Field	Do.
Longfellow	Garden	Do.
Red Kidney	Field	Do.
Red Valentine	Garden	Do.
White Kidney	Field	Do.
Pole:		
Golden Cluster Wax	Garden	Wax.
Kentucky Wonder Wax	do	Do.

VERY SUSCEPTIBLE

Dwarf:		
Blue Pod Small White	Field	Green.
California Pink	do	Do.
California Red	do	Do.
Genuine Small White	do	Do.
Great Northern	do	Do.
Large White	do	Do.
Pea Bean	do	Do.
Pinto	do	Do.

TABLE 3.—*Bean varieties grouped according to relative resistance and susceptibility to rust*—Continued

VERY SUSCEPTIBLE—Continued

Type and variety	Class	Kind of pod
Dwarf—Continued.		
Red Mexican	Field	Green.
Robust	do	Do.
Tennessee Green Pod	Garden	Do.
Pole.		
Case Knife	do	Do.
Creaseback	do	Do.
Kentucky Wonder	do	Do.
Kentucky Wonder Wax	do	Wax.
McCaslan Pole	do	Green.

ROOT ROTS

DESCRIPTION AND CAUSES

A number of different organisms may cause root rots of beans. Unfortunately, the symptoms caused by some of them are so similar that it is sometimes impossible to distinguish among them. Root rots occur more or less extensively wherever beans are grown, but on the whole a larger number of root parasites occur and cause more damage to the crop in the Southern States. The diseases of the roots are, for the most part, caused by organisms that live in the soil on decomposed vegetable matter, but which are capable of attacking beans as well as a large number of other crops when soil and other conditions become unfavorable for the best plant growth.

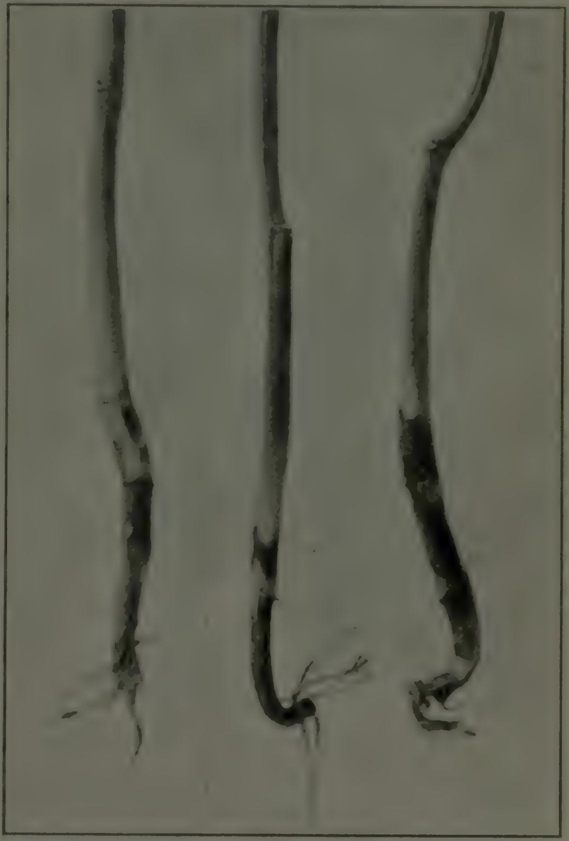


FIGURE 7.—Root rots, a group of diseases caused by several different fungi that inhabit the soil. They destroy the feeding roots and cause cankers on the stem at or below the level of the soil

Root rots, as a group, are characterized by the formation of cankers and lesions on the stem below the soil level (fig. 7) and on the small fibrous rootlets. These cankers and lesions may be of various sizes and may be gray, brown, black, or even bright red. The tips of the fibrous roots are frequently decayed for some distance from the end.

CONTROL

No effective control for the various root rots is known. However, the employment of certain cultural practices which can always be recommended will considerably lessen the severity of the disease.

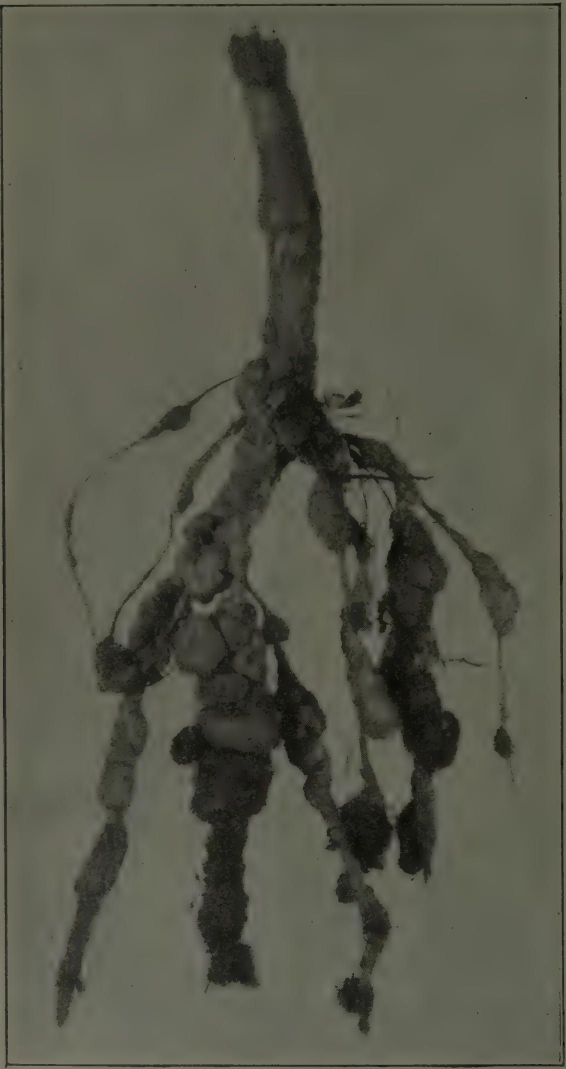


FIGURE 8.—Root knot. This disease is caused by a small parasitic eelworm or nematode which invades the roots. Note the galls formed at various places. Root-knot invasion retards the growth, reduces the yield, and often kills the plants

A rotation of at least two to three years is essential, the cropping system to include cereals (corn, oats, and others), clover, and alfalfa, plants on which the bean root-rotting organisms are rarely if ever found to produce any lasting damage.

Among the principal root rots, that produced by Rhizoctonia (well known on potatoes) is the one most frequently encountered. Fortunately, this organism is not an aggressive parasite under conditions conducive to strong, vigorously growing bean plants.

The organisms responsible for root rots seem to thrive best under conditions not ideal for the bean crop. Therefore, any measures that improve the general growing conditions of the beans will help to reduce the severity of root rots.

Since root-rot organisms are normal inhabitants of practically all soils, they can not be entirely eliminated. All that can be done is to make conditions so favorable for the bean plant that it will thrive in spite of the potential parasites in the soil.

ROOT KNOT

DESCRIPTION

Root knot, largely confined to the light sandy soils of the South and to similar regions in California, is characterized by enlarged, irregularly shaped, deformed fleshy galls (fig. 8) distributed on the bean root system. If the galls are broken open, pearl-white bodies about the size of a pinhead may often be seen. These are the female worms that cause the galls.

Occasionally the root-knot galls may be confused with the nodules that normally develop on the roots of garden and field beans, Lima beans, and other legumes. Careful comparison shows the two to be quite different. The nodules are usually smaller than the root-knot galls, more nearly round, and are attached somewhat loosely to the sides of the roots, whereas the root-knot galls are enlargements of the roots themselves. The bacteria that form the nodules change the nitrogen of the air into forms that are of some benefit to the plant and that are later changed into nitrates in the soil and thus become available to subsequent crops. Plants bearing nodules generally grow well and look healthy. On the other hand, plants with root knot are usually stunted, yellow, and sickly looking and may even be killed by the disease.

CAUSE

Root knot is caused by a parasitic eelworm, or nematode (*Caconema radicicola* (Greef, Cobb), so small as to be almost invisible to the naked eye. It enters the small roots and causes them to form the irregular swellings or galls characteristic of the disease. To a considerable extent these galls cut off the transport of food material from the roots to the rest of the plant. These little eelworms migrate very slowly in the soil, probably not covering more than 1 to 2 yards in a year. They overwinter in the soil.

CONTROL

The eelworms, or nemas as they are generally called, are parasitic on a large number of cultivated plants and on many weeds. However, a number of crops are practically immune to their attack. Among the latter may be mentioned the Iron, Brabham, Victor, and Monetta cowpeas, the Laredo soybean, velvetbeans, corn, barley, rye, redtop, sorghum, timothy, wheat, and winter oats.

The most satisfactory method of controlling the disease is to practice rotation with immune crops for three or more years, or to allow the land to lie fallow for three years in order to starve out the nemas. Clean cultivation should be practiced to prevent the growth of susceptible weeds on which the nemas could feed. The nemas may be transported from one field to another or over long distances in the tubers, bulbs, and roots of growing plants; by implements and drainage water; by farm animals allowed to roam from one field to another; and probably by other means. Distribution of the nemas by any of these means should be prevented as far as possible.

CURLY TOP

DESCRIPTION

Curly top of beans was first reported in 1924, from southern Idaho. In certain stages of development its symptoms resemble those of bean mosaic, although in the later stages they are quite distinct. Plants affected with curly top are decidedly dwarfed. Young plants show the most pronounced symptoms on the trifoliolate leaves, which pucker and curl downward, and show a clearing of the leaf veins. (Fig. 9.) On some varieties the young leaves are decidedly dwarfed and darker green than normal. Cupping of the leaves sometimes continues until each leaf resembles a small green ball. The young leaves frequently cease to develop, turn yellow, and curl downward. Such leaves are thicker than normal and very brittle, readily breaking off from the main stem. A plant thus affected generally dies before the pods develop.

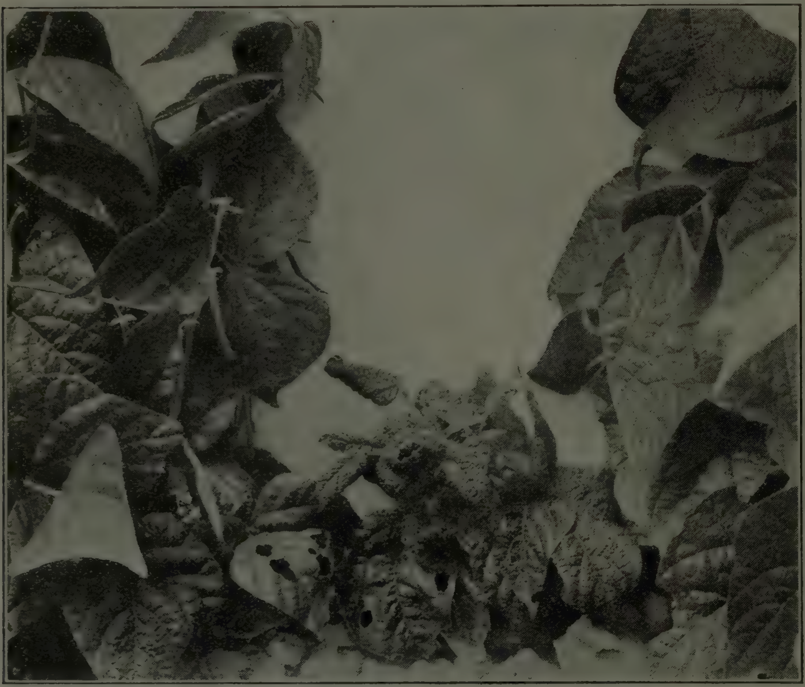


FIGURE 9.—Plants infected with curly top are dwarfed and the leaves yellowed, puckered, and curled. Note healthy plants on either side of the diseased one. Curly top is spread by a small leaf hopper. The crop is sometimes completely destroyed. The disease occurs only in some of the Western States

Plants infected late in the season do not always develop typical symptoms of the disease, and generally grow to maturity. The pods that are produced are often stunted, this being one of the symptoms. The disease is not seed borne.

CAUSE

The cause of curly top, like that of mosaic, is undetermined. The disease is spread from plant to plant by a leaf hopper (*Eutettix* *tenellus* Baker), frequently referred to in some western sections as the "white fly." Before infecting a bean plant the leaf hopper must have fed on some curly-top infected plant, either bean, beet, tomato, or one of many other hosts susceptible to the disease. The symptoms appear about 10 days to 2 weeks after infection. If severely infected the plant may die within a few weeks after the first appearance of symptoms.

Since the disease is not transmitted except by the leaf hopper, curly top is prevalent only where that insect thrives, viz in Idaho, Utah, Oregon, Washington, California, New Mexico, and parts of Colorado and Wyoming. The severity of the disease in these States is dependent on the leaf-hopper population, which varies from season to season.

CONTROL

No control measures for curly top have been developed. The only variety of beans known to be resistant to curly top is the Red Mexican, a field type. In regions where leaf hoppers are abundant this variety resists the disease and produces a normal crop. Since curly top is not seed borne, seed originating where the disease is prevalent may safely be planted in any section of the country.

BALDHEAD (SNAKEHEAD)

DESCRIPTION

An examination of bean fields soon after the seedlings emerge from the ground often reveals a considerable percentage of the young plants with no growing tips. (Fig. 10.) The stem above the cotyledons, which in normal plants would develop further growth, is broken off, leaving only a bare stump. Sometimes this stump will grow for a short time and extend an inch or more above the cotyledons. Occasionally the plant dies without making much more growth, but usually new shoots are developed in the axils of the cotyledons, and a few flowers and pods may be produced. However, the plant always remains small and is generally smothered and crowded out by more vigorous neighboring plants. This abnormality is known as baldhead or snakehead.

CAUSE

Baldhead is known to be caused in three different ways: (1) By injury of the embryo in threshing, (2) by insects, and (3) by bacteria and fungi. More baldhead is caused by the threshing machine than by any other agency. The drier the seed and the greater the speed of the cylinders in the threshing machine, the greater the damage is likely to be. As much as 20 to 30 per cent of the seed of some varieties may be damaged in this way.

During some seasons the seed-corn maggot causes considerable damage to the terminal bud, either before or at the time the seedling is emerging from the soil. The maggot, eating into the growing bud or eating it off the plant, produces an injury somewhat resembling that caused by the threshing machine. The plant rarely recovers from this condition.

Bacterial organisms which harbor beneath the seed coats also cause baldhead. As the seed germinates, these organisms attack the growing bud of the young plant and partially or completely destroy it so that it is unable to grow into a productive plant. Baldhead caused by bacteria will not occur in seed that is free of blight.

CONTROL

There is no remedy for baldhead. The grower should refuse to accept seed of which a high percentage is cracked. Such seed, if planted, will produce a considerable number of baldhead plants.

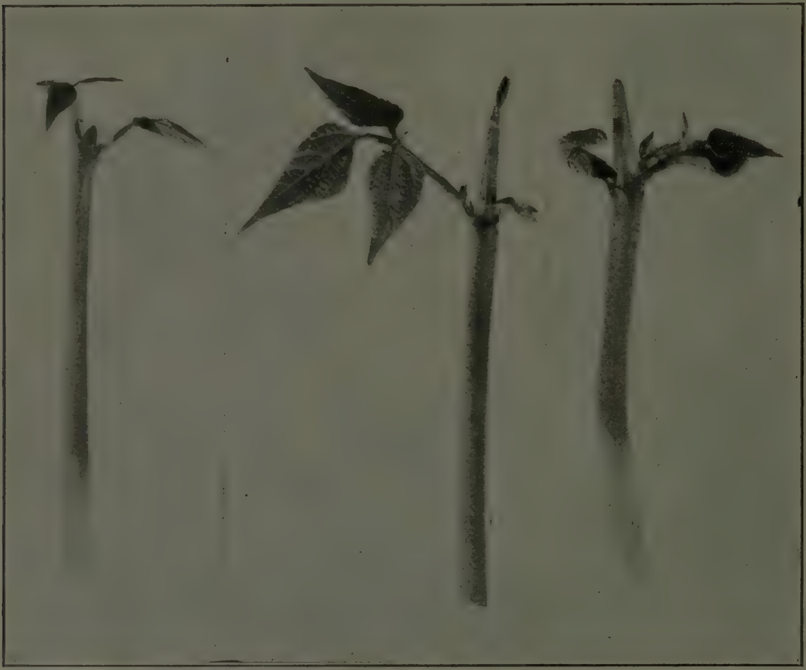


FIGURE 10.—Baldhead. The embryonic plant in the seed is damaged when the beans are threshed, so that growth is impossible. The injury is done by the seed being hurled against the teeth of the cylinders and concaves of the threshing machine. Similar injury to the terminal bud is sometimes caused by insects, bacteria, and fungi

Control of baldhead caused by the threshing machine rests wholly in the hands of those who thresh the seed. A reduction in the speed of the cylinders probably would reduce the loss. The use of rubber shields on the teeth of the cylinders and concaves or the substitution of some substance not so hard as the iron teeth would also be helpful.

The use of disease-free seed will eliminate baldhead caused by bacteria and fungi.

POWDERY MILDEW

DESCRIPTION

Powdery mildew is widely distributed, having been reported or observed in almost all parts of the United States. It is more abundant in the Southern States and along the Pacific coast than elsewhere and usually causes the most damage to crops maturing late in the fall and those produced in the extreme South during the winter.

Powdery mildew is characterized by the production of a white talclike substance on all parts of the plant aboveground. (Fig. 11.) The leaves turn yellow, cup downward, and, in the case of severe attacks, fall off. The pods are often malformed, small, poorly filled, and frequently fall off without bearing any seed. The pods and stems are oftentimes purplish in color.

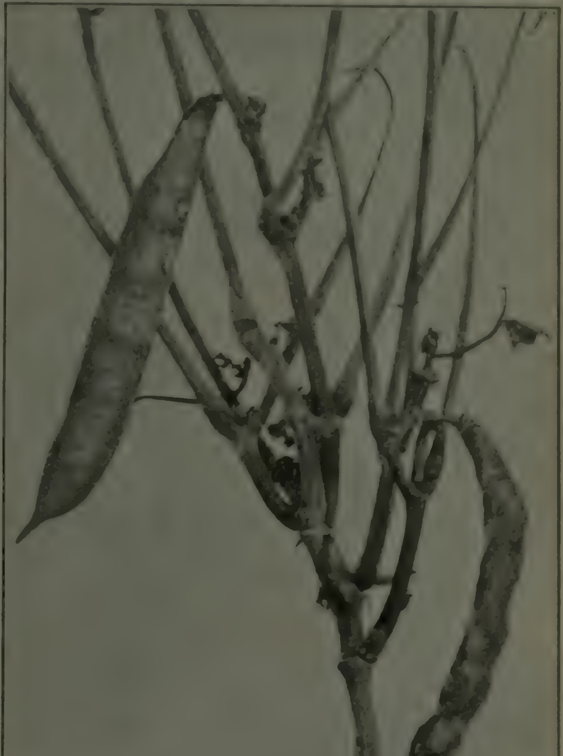


FIGURE 11.—Powdery mildew, a disease characterized by a white, powdery, dustlike covering on the leaves and other aboveground parts of the plant. It is here shown on the pods and stem

CAUSE

Powdery mildew is caused by a fungus (*Erysiphe polygoni* DC.) which is parasitic on more than 300 other host plants. The spores, produced in great numbers on the leaves, pods, and stems, are easily dislodged and carried by the wind and other agencies from one plant to another. Powdery mildew develops so rapidly that an entire crop may be badly damaged within a few days.

CONTROL

Powdery mildew may be held in check by one or two dustings with powdered sulphur. The first application should be made as soon as there is any evidence of the disease. The second should follow within a week or 10 days.

ASHY STEM BLIGHT

DESCRIPTION

Ashy stem blight infections begin at or below the level of the soil and extend down the stem into the roots and upward, often some distance, into the branches. The lesions on young plants are somewhat sunken and reddish brown in color and differ from those on older stems in that the latter are usually little or not at all sunken. As the lesions enlarge they turn gray at the center, in which are found numerous black fruiting bodies about the size of a pin point. These fruiting bodies stand out in sharp contrast against the ashy gray background. Since the plants usually become infected when quite young, they are generally killed before they produce seed.

The losses from ashy stem blight are sometimes very large. In Mississippi as much as 65 per cent of the crop has been destroyed, the amount of loss depending to a considerable extent on weather conditions. It is highest during seasons with considerable rainfall, and is often entirely absent in dry seasons. Considerable loss has also been reported from South Carolina, North Carolina, and other Southern States.

The ashy stem blight organism attacks Lima beans as well as garden beans. It is distributed quite generally in the Southern States, along the Atlantic seaboard, and in California.

CAUSE

Ashy stem blight is caused by a fungus (*Macrophoma phaseoli* Maubl.). Numerous spores are produced in the black fruiting bodies on the stems. The indications are that the organism survives from one season to the next on plants left in the field from a former crop.

CONTROL

No control for ashy stem blight has been developed. It is not unlikely that a rotation with crops other than beans, Lima beans, and sweetpotatoes for two or three years would be helpful.

SUN SCALD

Sun scald usually occurs near the end of the growing season when the beans are reaching maturity. The lesions, most conspicuous on the pods, appear first as tiny brown or reddish spots on that part of the plant exposed to the sun. The spots enlarge and later appear as short streaks or markings extending diagonally between the sutures of the pod. These discolorations may easily be mistaken for early bacterial-blight infections and in some cases can not be properly diagnosed except with a microscope. In the later stages, however, there is little difficulty in distinguishing these lesions, since a dried, scaly, white or yellow, slimy mass is associated with bacterial-blight infections, whereas no exudate is present with sun scald.

These small spots or streaks increase in size and sometimes form slightly sunken brown areas. If rapid spread occurs the lesion may extend over most of the pod that is exposed to the sun. This spotting may eventually appear on the opposite side of the pod, but is never as serious as on the surface exposed to the sun. Sometimes the markings are noted on the stems and petioles of the plant as brownish-red streaks and are seen only on that side of the plant exposed to the sun.

No appreciable loss is caused by sun scald. Occasionally, when pod spotting is severe, the seeds will be slightly discolored, giving the appearance of bacterial infection. Such seed is often difficult to detect, especially with dark-seeded varieties. The germination of seed so discolored is in no way affected and normal plants are produced.

The discoloration of the pods and stems is a result of exposure to the direct rays of the sun and is in no way associated with any organism, and it does not occur when the plant parts are shaded.

No practical control for sun scald is known.

ANGULAR LEAF SPOT

Angular leaf spot of beans, caused by a fungus (*Isariopsis griscola* Sacc.), occurs occasionally in the Eastern States and is found mostly on the underside of the leaves and sometimes on the pods. On the leaves it causes small angular spots which may be numerous enough to cause some defoliation. The spots are brown at first, but, when the fungus fruits, the surface of the lesions becomes more or less gray. The spots on the pods are usually small, although they may sometimes be large and noticeable. They are conspicuous because they are black with brown or red centers.

Angular leaf spot is rarely severe or common enough to require remedial measures, and none are recommended.

DISEASES OF LIMA BEANS

DOWNY MILDEW

DESCRIPTION

Downy mildew of Lima beans can be recognized by the white, cottony growth which forms in large patches on the pods. (Fig. 12.) It sometimes occurs on the tender shoots and flower parts and occasionally on the leaves. The young branches are distorted, but a profuse fungous growth, such as is found on the pods, does not occur on them. A purplish border separates the dense cottony growth on the pod from the healthy tissue. The fungous threads grow through the pods and into the seed, where the organism may live through the winter. Such seed, if planted, may be a source of the

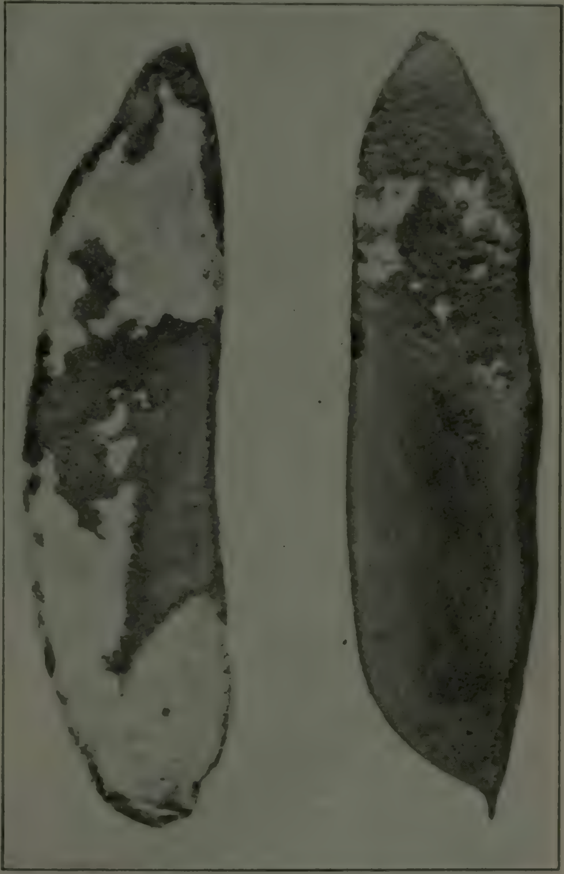


FIGURE 12.—Downy mildew, a white, cottony, fungous growth on the pods of Lima beans. Damp, rainy weather is favorable for its development

disease the next year. If the pods become diseased while quite young they usually wither and die without producing seed.

Downy mildew may cause heavy damage during seasons favorable for the development of the fungus. It is favored by wet weather, cool nights, heavy dews, and fairly warm days. The disease is most prevalent along the Atlantic seaboard, but has been reported inland and from California. It is spread by winds, rains, pickers, and probably by insects and other means.

CAUSE

Downy mildew is caused by a fungus (*Phytophthora phaseoli* Thax.) and occurs only on Lima beans. It may live from one season to the next in two or three ways. The causal fungus penetrates the seed and lives in it throughout the winter. It also survives the winter in dead vines and pods in the field. Both the seed and the débris are sources of infection of the new crop.

CONTROL

Inasmuch as the fungus causing downy mildew is carried by the seed, only clean seed should be planted. Where this disease occurs it is never advisable to save seed for the next crop. It is far better to obtain seed grown in the West, as, for example, Colorado and California, where downy mildew rarely occurs. Collecting and burning dead vines and pods in the fall after the crop is harvested help to control the disease. A crop rotation of two to three years should be practiced if possible. Spraying the vines with a 4-4-50 Bordeaux mixture has been recommended, but to be effective such spraying should be started before the disease becomes established. Since downy mildew does not occur regularly every year, and usually not more than once in every three or four years, it is impossible to foretell when a fungicide should be applied. If Bordeaux is used, it should be applied each year before the disease occurs. It is doubtful whether this would be a profitable procedure, since Bordeaux is liable to be deposited on the pods and might thus affect their market value.

POD BLIGHT

DESCRIPTION

Pod blight is more prevalent on the pole varieties than on the bush varieties of Lima beans. It has been reported from most of the States along the Atlantic seaboard and from Ohio and West Virginia, and it probably occurs elsewhere. During seasons favorable to the disease it causes considerable damage to the commercial crop. The disease appears first on the leaves as brown irregularly shaped patches which vary in size with age and often attain a diameter of one-fourth to three-fourths of an inch. During the latter part of the growing season the causal fungus spreads to the pods, causing pale, somewhat watery-looking spots. These spots (fig. 13) slowly enlarge and gradually darken. In these spots greenish-gray pimples about the size of a pinhead, arranged roughly in circles, develop. When these pimples break through the skin of the pod they turn dark brown to nearly black. They are the bodies in which the spores of the fungus are borne. They rarely occur on the stem of the living plant, but are prevalent on the leaves before they are found on the pods.

CAUSE

Pod blight is caused by a fungus (*Diaporthe phaseolorum* (Cke. and Ell.) Sacc.) which lives through the winter on dead vines and pods left in the field. It has also been found on the seed, but its presence there is not of any great economic importance, since most of the seed is grown along the Pacific coast, where the disease does not occur.

CONTROL

Little control has been attempted. Spraying the vines with a 4-4-50 Bordeaux mixture has been recommended but not generally practiced. If spraying is attempted it should be started when the plants are about 2 feet tall. Inasmuch as the causal organism is carried from one season to the next on dead vines and pods, they should be gathered up and burned as soon as the crop is harvested. No seed should be saved from fields in which pod blight has occurred. Seed grown in the West should be planted.

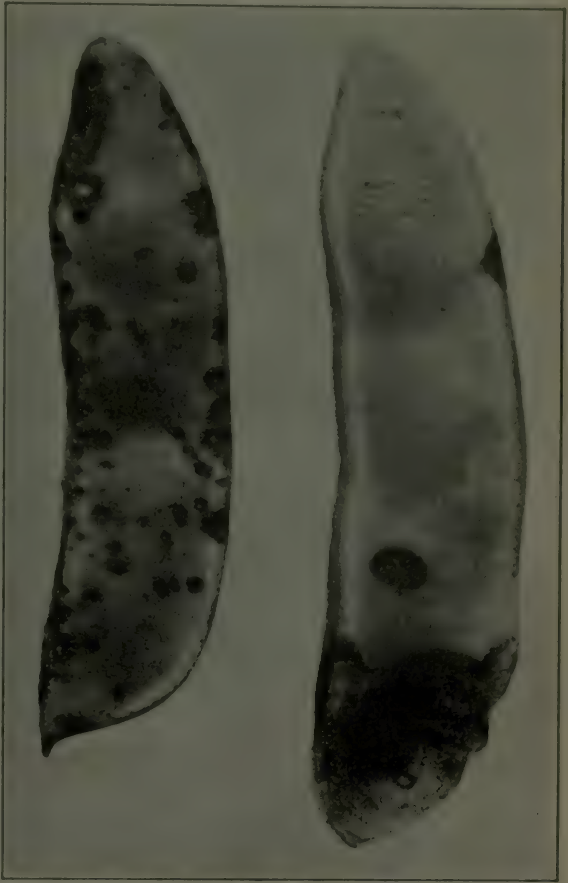


FIGURE 13.- Pod blight of Lima beans. It appears first on the leaves and later on the pods, where large, unsightly dead cankers are formed. Numerous spores of the fungus form in fruiting bodies in the cankers

BACTERIAL SPOT

Bacterial spot occurs on the leaves, stems, and pods of Lima beans. The lesions on the leaves are small, reddish brown, and irregular in shape and size. The dead plant cells at the center of the spots often dry and fall away, leaving small holes. Small spots or lesions are often found on the stems and pods.

The damage caused by this disease is rarely enough to require control measures, and none have been worked out. Crop rotation and the use of disease-free seed should be practiced.

The bacterial spot of Lima beans is caused by bacteria (*Bacterium vignae* Gardner and Kendrick) that are very similar to but not identical with the organism causing the blight of garden and field beans.

YEAST SPOT

Yeast spot, a disease of the seed only, was discovered on Lima beans in Virginia and was later reported in Tennessee, Alabama, and Illinois. In 1930 the disease was prevalent on garden beans in the northwestern part of the United States, which indicates its wide distribution. It causes dark, irregularly shaped, sunken spots on the seed coat. (Fig. 14.) While the causal fungus (*Nematospora phaseoli* S. A. Wingard) is able to attack the seed at any time during its growth, it is most destructive to young, immature seed. If attacked when very young, the seed will not mature, but instead dries up in the pod. Infection is apparently brought about by an insect which punctures the green succulent pod and the seed within it. Evidence of the yeast spot does not appear on the outside of the pod. The damaged condition of the seed can be seen only after splitting the pod open.

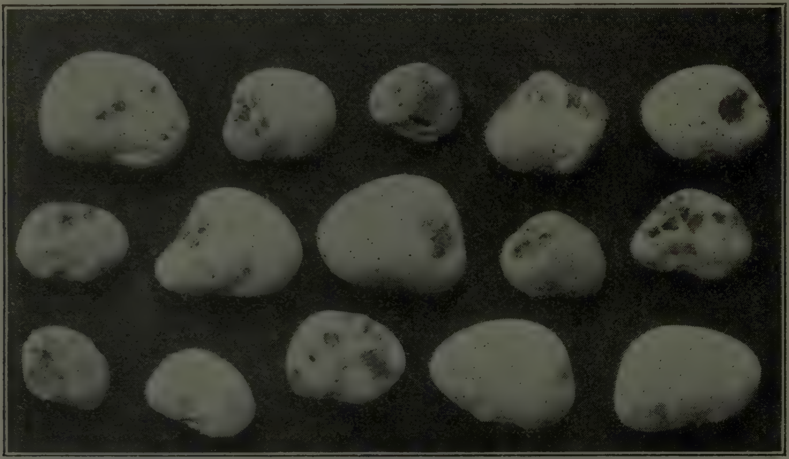


FIGURE 14.—Yeast spot, found mostly on Lima beans. Irregularly shaped cankers are produced on the seed by a yeast fungus which gains entrance through insect punctures of the pod

The infection of the seed is reported to range from a trace to as much as 90 per cent. Yeast spot has occurred on several different varieties of Lima beans, but the Sieva type appears to be especially susceptible. It has been reported on some varieties of garden beans and cowpeas. Infection is slight during the early part of the growing season, but increases in severity as the plants near maturity.

No control measures have been developed. Any control would require the protection of the pods against being punctured by the insects that carry the causal agent.

BALDHEAD (SNAKEHEAD)

Baldhead (snakehead) has been fully discussed under garden and field beans. The facts brought out apply also for Lima beans. (P. 19.)

ASHY STEM BLIGHT

For discussion of ashy stem blight, see page 21.

DISEASES OF GARDEN AND LIMA BEANS FOUND IN TRANSIT

The diseases of snap as well as Lima beans that are found in transit are further manifestations of field diseases. There is probably no malady of beans peculiar to transit conditions, all of them being referable to conditions in the field during harvest or before it.

Diseases appearing on the pods as somewhat definite spots show much the same characteristics in transit as in the field, any differences being attributable to the changes that would naturally occur in any fruit after being removed from the plant for some time. Ideal shipping conditions should include maximum aeration and a temperature and humidity that would reduce excessive drying out and at the same time prevent sweating.

Some diseases, like anthracnose and bacterial blight, will develop appreciably during four or five days in transit under high temperature and high humidity. While it has been proved that anthracnose will initiate new infections under transit conditions, bacterial blight apparently can only continue the development of infections already started.

Many of the root-rot fungi attack pods when they are in contact with the soil. Such infected pods, when shipped or held at the market under reasonably high temperature and humidity, may become centers of decay whose extent depends on the length of exposure to favorable conditions.

Inasmuch as transit diseases are directly correlated with field conditions, supplemented and aggravated by improper conditions of shipment, rigid application of control measures recommended for field diseases is of primary importance. After a crop has been raised in the best possible manner, it should be carefully graded and all beans showing blemishes and disease spots discarded. The beans should be picked when the vines are dry, and the filled hampers should be protected from the direct rays of the sun and kept from getting wet. When possible the beans should be precooled and shipped in iced cars; otherwise they should be shipped as quickly as possible and in hampers so packed as to allow the maximum aeration consistent with freedom from leakage and breakage.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	Arthur M. Hyde.
Assistant Secretary	R. W. Dunlap.
Director of Scientific Work	A. F. Woods.
Director of Regulatory Work	Walter G. Campbell.
Director of Extension Work	C. W. Warburton.
Director of Personnel and Business Administration.	W. W. Stockberger.
Director of Information	M. S. Eisenhower.
Solicitor	E. L. Marshall.
Weather Bureau	Charles F. Marvin, *Chief.*
Bureau of Animal Industry	John R. Mohler, *Chief.*
Bureau of Dairy Industry	O. E. Reed, *Chief.*
Bureau of Plant Industry	William A. Taylor, *Chief.*
Forest Service	R. Y. Stuart, *Chief.*
Bureau of Chemistry and Soils	H. G. Knight, *Chief.*
Bureau of Entomology	C. L. Marlatt, *Chief.*
Bureau of Biological Survey	Paul G. Redington, *Chief.*
Bureau of Public Roads	Thomas H. MacDonald, *Chief.*
Bureau of Agricultural Engineering	S. H. McCrory, *Chief.*
Bureau of Agricultural Economics	Nils A. Olsen, *Chief.*
Bureau of Home Economics	Louise Stanley, *Chief.*
Bureau of Plant Quarantine	Lee A. Strong, *Chief.*
Grain Futures Administration	J. W. T. Duvel, *Chief.*
Food and Drug Administration	Walter G. Campbell, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	James T. Jardine, *Chief.*
Office of Cooperative Extension Work	C. B. Smith, *Chief.*
Library	Claribel R. Barnett, *Librarian.*

U. S. GOVERNMENT PRINTING OFFICE: 1932

For sale by the Superintendent of Documents, Washington, D. C. - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1693

Rev. Sep '40

Growing Christmas Holly ON THE FARM

THE PRODUCTION of Christmas holly greens is a practical means of augmenting farm income in certain portions of the United States. The American and common English hollies do not grow rapidly, but normally are long-lived and capable of producing greens for a century or more if properly managed.

This bulletin describes methods of producing Christmas holly greens from the American and the English hollies and from rapid-growing varieties of the latter. The proper management of natural stands containing American holly is outlined. Practical details of the care and handling of holly seeds, culture of seedlings, vegetative propagation, transplanting, field plantings, care of plantations, and harvesting and marketing greens, are presented.

Washington, D. C. Issued October, 1932

GROWING CHRISTMAS HOLLY ON THE FARM[1]

By **Perkins Coville**, *Associate Silviculturist, Branch of Research, Forest Service*

CONTENTS

Page
Characteristics of American and English hollies 1
  General appearance 3
  Male and female trees 4
  Growth rate 5
Sections adapted to holly growing 6
Soil conditions and sites suitable for holly growing 6
Management of woodland areas containing American holly 7
Obtaining holly stock for planting 8
  Wild seedling stock 8
  Reproduction from seed 9
  Vegetative propagation 10
  Transplanting 12
Details of establishing the plantation 13
  General considerations 13
  Cultivation 14
  Soil fertility and fertilizer 14
  Spacing the trees 14
  Planting recommendations 15
  Special caution 16
Harvesting holly 16
Traffic in Christmas holly 17
Shipment of holly 19
Marketing holly 20
Other hollies and hollylike plants 21

EVERGREEN HOLLY trees are beautiful and long-lived and are an ornamental asset to the property upon which they grow. (Fig. 1.) Growing holly for Christmas greens offers to farmers in some sections of the southeastern United States an opportunity to supplement their other farm income. There are indications that the market demand for holly has been increasing. Holly for sale may be produced from areas in which wild American holly is growing, or from planted American and English hollies.

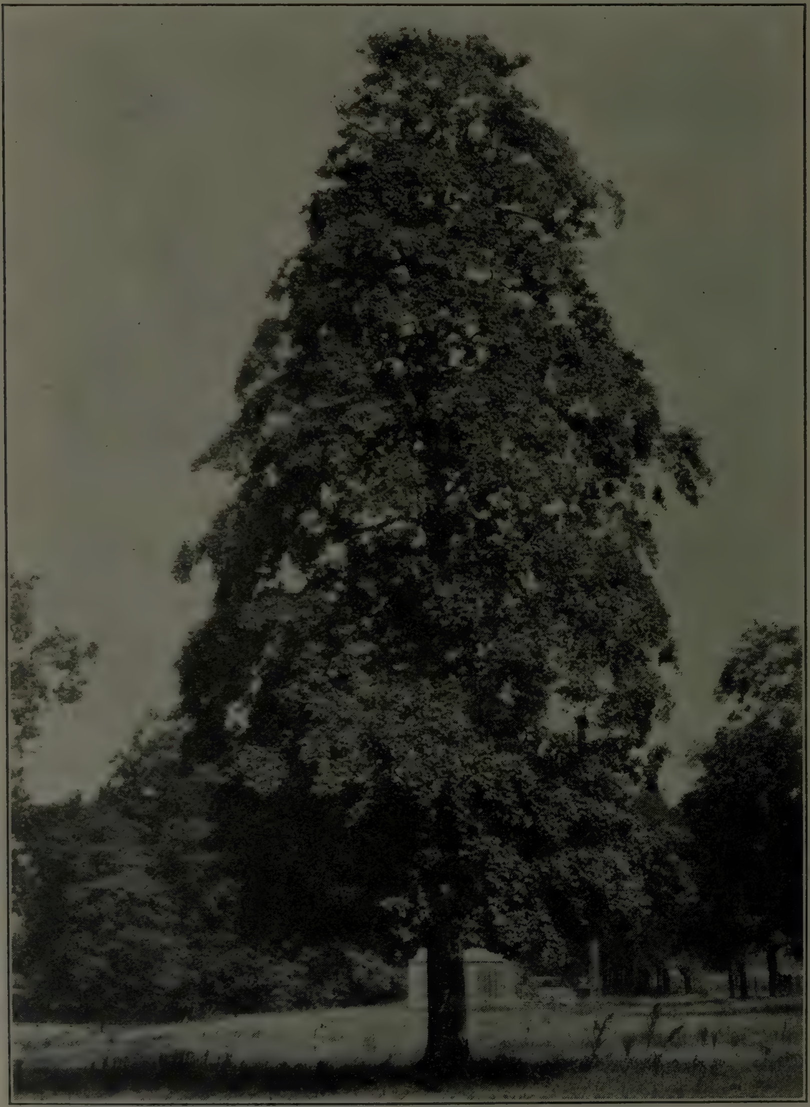
The sentiment of some organizations and persons against destructive harvesting of wild holly branches and of evergreen trees for the Christmas trade has reacted, in some sections, against cultivated material actually grown for sale. Growing cultivated holly and Christmas trees or wild holly for sale, if conservatively managed, is a legitimate business, however, and not antagonistic to the sentiment for protection of wild stock. No reasonable objection can be made to marketing holly that has been grown for sale, either under cultivation or under conservative management. There should be public recognition of the rights of those who own and manage, under proper forestry practices, the holly that has been established naturally.

CHARACTERISTICS OF AMERICAN AND ENGLISH HOLLIES

More than 300 species of Ilex (the holly genus) are mentioned by Rehder in his Manual of Cultivated Trees and Shrubs, as native to the temperate and tropical regions of both hemispheres. Probably the greatest collection of different hollies is to be found at the Kew Gardens in England, where the "holly walk," planned and inaugurated in 1874, now contains some 120 species, varieties, and hybrids.

---

[1] The horticultural features of this bulletin have been reviewed and approved by the Bureau of Plant Industry.



F 247278

FIGURE 1.—Magnificent specimen of a mature American holly tree which grew in Desha County, Ark., near the Mississippi River, was about 50 feet in height and 15 inches in diameter, and bore annually a full load of bright red berries

Many of the recognized hollies are garden hollies not particularly suitable for Christmas greens. Only the American holly (*Ilex opaca*), the English holly (*I. aquifolium*), and varieties and hybrids of the English holly are used for greens. The Western Washington

Experiment Station, in a mimeographed circular on the culture of Christmas holly, states that, although there are many varieties of the English holly—

> only the Dutch, common English, and Select (French) English are common in the Northwest. Commercially it can not be profitable to plant any but the best trees of the Select varieties. The blue-stemmed and green-stemmed strains appear to be equally desirable to the trade. The Select English trees are vigorous growers, have berries which are large and bright red, and leaves that are thick, glossy, curly, and dark green.

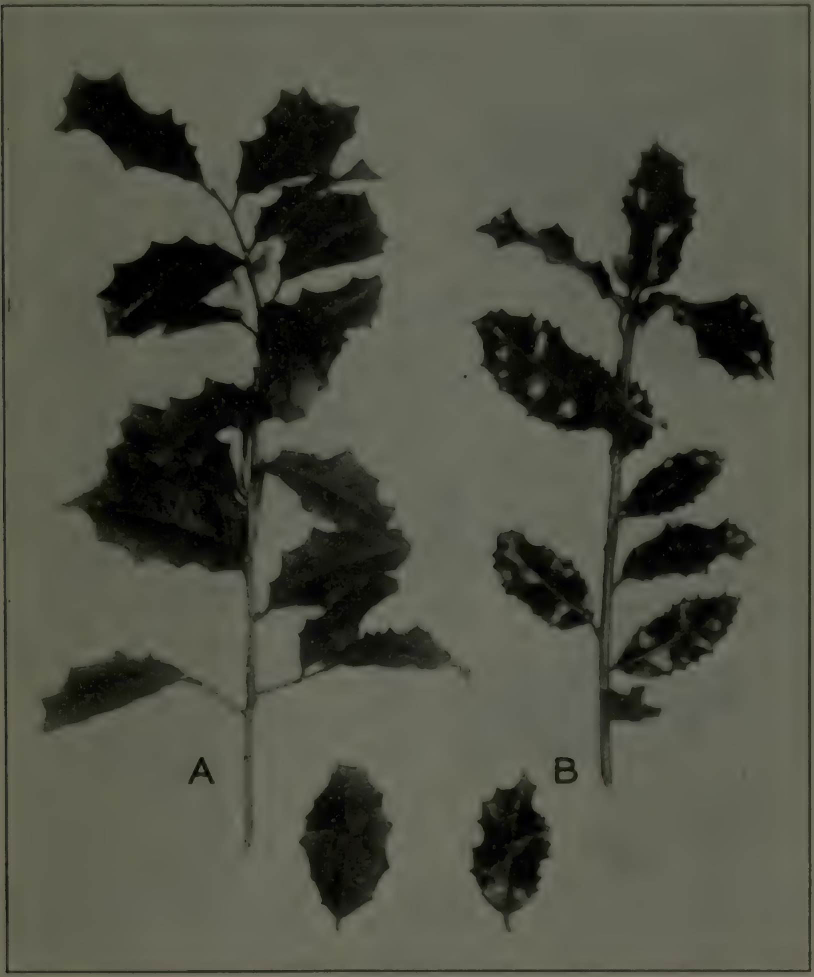


FIGURE 2.—A, Spray of American holly; B, spray of English holly

GENERAL APPEARANCE

The English and American holly trees have rich green leaves, usually with the characteristic prickles or teeth along the margins. (Fig. 2.) The fruiting branches bear round scarlet berries, usually solitary on American holly (fig. 3) and clustered on English holly. (Fig. 4.) The American holly rarely reaches a height greater than 40 or 45 feet, and has spreading branches forming a narrow pyramidal head. The leaves are usually elliptical and are from 2 to 4 inches long, mostly with large remote spiny teeth, but rarely entirely without teeth. The English holly, on the other hand, reaches heights ranging from 45 to 70 feet and has short spreading branches usually forming a dense pyramidal or oblong head. The leaves are generally ovate and are from 1¼ to 2¾ inches long. The leaf margins are wavy, with large triangular spiny teeth, which tend to disappear on old trees.[2]

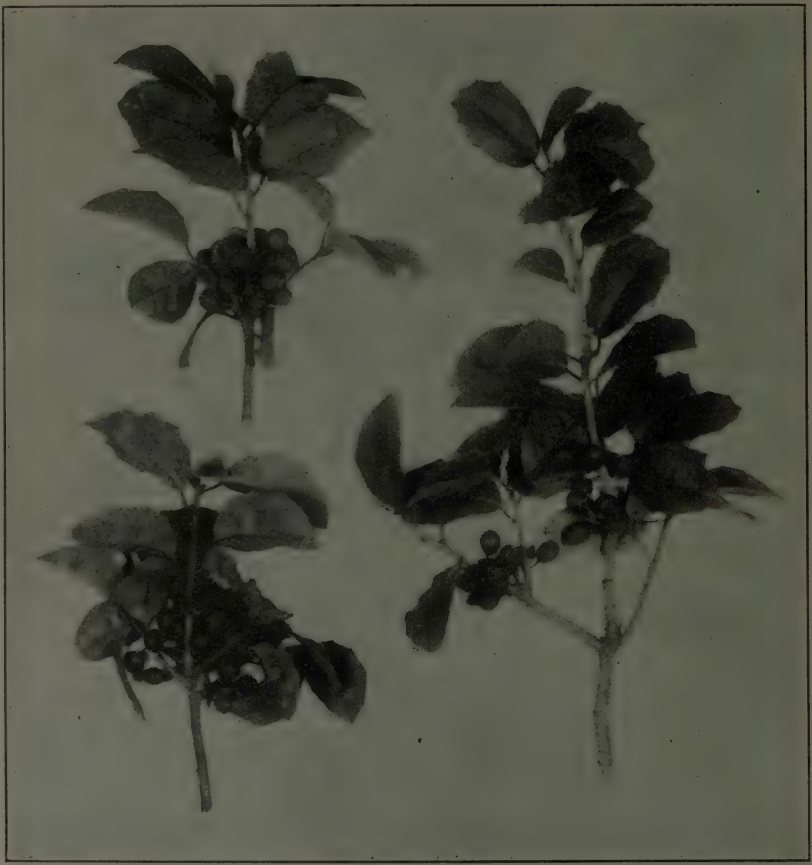

F245624

FIGURE 3.—Sprays of American holly showing the groups of solitary berries produced by female plants

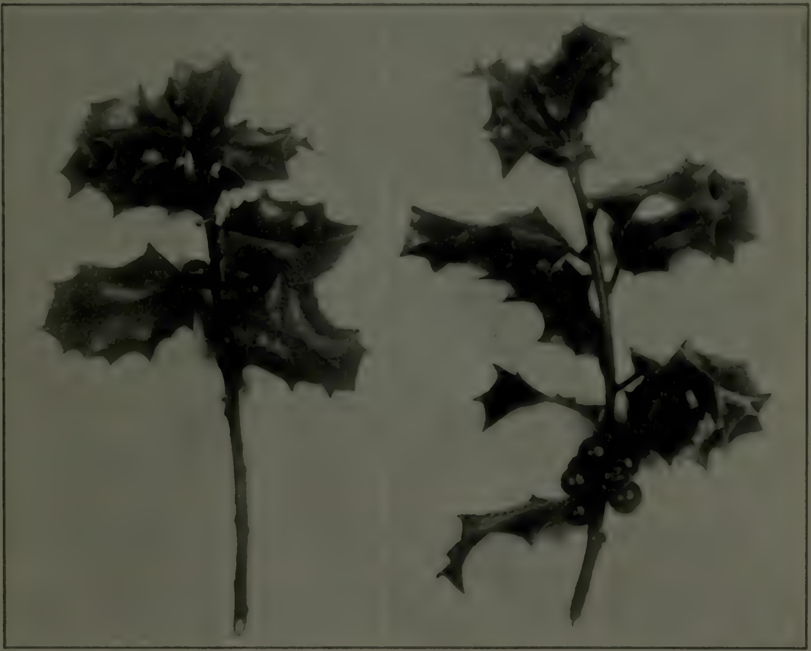
MALE AND FEMALE TREES

The American and English hollies are diœcious; that is, the male and female flowers are commonly borne on separate trees. Berries are borne only on female trees, or on the female portions of those occasional trees which bear both male and female flowers. When seedlings are grown, it might be expected that the male and female trees would be present in about equal proportions, but this is not the case; seedlings from American and English holly seed are often in the proportion of 10 male to 1 female tree. Plants may first bear flowers at an age between 5 and 12 years; until that time the male and female plants can not be distinguished.

---

[2] Additional data on other species of Ilex and hollylike plants are given on p. 21.

The fruit of the evergreen hollies is the well-known round red berry which contains from 2 to 8 (usually 4) seeds. The berries are usually one-quarter inch in diameter, but some varieties of the English holly have larger, more brilliantly colored berries that add greatly to the beauty of the sprays on which they are borne.



F222232

FIGURE 4.—Sprays of English holly showing the berries in clusters. Note the beauty of the stiff, glossy leaves

GROWTH RATE

The growth rate of hollies, which in general is rather slow, varies according to the fertility of the soil, the length of the growing season, and climatic conditions. The growth to be expected from wild native holly can not be foretold, since many variable factors enter into consideration. Wild growth in nearly all cases is slower than that of trees planted in the open and kept growing under the best conditions. In exceptional cases grafted trees have been known to reach a height of 6 feet in three years and to bear fruit in five years, but this rate of growth does not apply to most plantations. In the

East the best trees probably will reach 8 to 10 feet in height when the plantations are 12 to 20 years old. In some plantations of holly in the Pacific Northwest the trees have reached 15 feet in height when 20 years old.

SECTIONS ADAPTED TO HOLLY GROWING

The American holly formerly had a natural distribution from Massachusetts to Missouri and south to Florida and Texas. Destructive harvesting has practically eliminated the species in the region from Massachusetts to central New Jersey, except where it occurs on protected properties. Probably the region most favorable for growing the species commercially is from Norfolk, Va., to Florida, within 50 or 60 miles of the coast, and westward in the Gulf region to Louisiana; but a few nurseries as far north as Long Island and Massachusetts are apparently growing American holly plants successfully.

The English holly is not so hardy as the American; and though it may be successful in the southeastern United States, it is not likely to survive if planted farther north than Washington, D. C. In the northern part of this range it should not be planted in exposed situations or at very high elevations. Some sections of the Pacific Northwest offer excellent climatic conditions for the species. In the vicinity of Puget Sound the mildness and humidity of the climate are similar to those of England, and English holly or some of its variations is grown on numerous holly ranches. The species grows well in the lower Columbia River Basin, though some trees are usually frozen back during severe winters, and it is being grown in nurseries as far south as San Francisco, Calif. It is doubtful, however, that the species can be recommended for holly plantations in California.

SOIL CONDITIONS AND SITES SUITABLE FOR HOLLY GROWING

Though hollies will exist in a variety of soils, they grow best in well-drained, deep, sandy or gravelly loam soil that is fairly strongly acid or what is known as subacid. For commercial holly growing, badly drained land, though acid, should be avoided, as conditions attending poor drainage more than offset the advantages of the acidity.

In sections where damage is likely to occur from unseasonable frosts it is desirable to locate holly plantations on areas having good air drainage to avoid "frost pockets." In the Pacific Northwest holly berries and sprays seem to develop best after a damp, cool spring. For the best growth of the holly and for berry production the site should be protected from strong, drying winds, so that moisture can be conserved.

Upon some farms are small units of good soil difficult to keep in annual crops because of their isolation or for other reasons. Such locations offer opportunities for growing holly in solid plantations. Once planted to holly, such an area needs only occasional cultivation, and the fertility of the site promises better growth and subsequent returns than can be had from poor soils.

MANAGEMENT OF WOODLAND AREAS CONTAINING AMERICAN HOLLY

On many areas in the Southeastern and Gulf States native American holly grows in more or less abundance. It is a true forest species and occurs in a varying admixture with other trees. As it usually favors the moister situations and the richer soils, it is most often associated with hardwood species. The individual trees are sometimes widely scattered. As holly is relatively slow growing and somewhat tolerant of shade, the trees usually are overtopped by such species as red maple, tupelo, and red gum (known in cultivation as sweet gum), which, for the most part, grow more rapidly and demand more light. The competition with these associated trees and with vines often results in much slower growth of holly than would otherwise be the case, and also to a considerable extent in poor form and rather thin foliage.

Where natural holly trees are already established, particularly when they are too large for convenient transplanting, it would be better to consider whether Christmas greens can be produced more profitably by proper care of the trees already established than by moving the trees to the plantation. These trees often represent many years of growth that can be capitalized. The treatment necessary to transform these poorly formed forest hollies, and those of better quality as well, into more desirable and profitable ones is relatively simple. It involves merely giving the trees an opportunity to develop their crowns and to increase their growth rate. It would not be necessary in every case to remove all of the trees surrounding the holly, since usually the crowns of only one or two trees are casting the shade which suppresses it. Removal of these trees either by cutting or by girdling is apparently all that is called for. Where vines, chiefly grapevines, are found, they should be cut. Poorly developed and injured trees may be improved by pruning. In open woodlands, where the spacing of trees is irregular and considerable areas are unoccupied, it may often be desirable to plant wild or nursery-grown holly plants in openings so as to utilize the area more fully.

Because holly tolerates shade it bears leaves close to the ground, and many of those which drop remain close to the trunk of the tree. Since green leaves, as well as the dead ones, burn readily and the bark is easily injured by high temperatures, stands containing holly should be protected from fire. Even light fires, which not infrequently burn in the litter and underbrush in the lowland forest, often kill the whole holly tree, or at least a considerable portion of the lower branches. (Fig. 5.)

Grazing is not particularly injurious to hollies; but where small plants are present it should be restricted in order to prevent injury from trampling. In areas where livestock concentrates the packing of the soil is detrimental even to large holly trees.

Solitary holly trees will often yield enough greens to pay for their care if a good local market for small quantities of greens is available. Single holly trees can be freed from the competition of other trees in the forest and fertilizer can be worked into the soil about their bases to increase twig growth. Proper trimming of the twigs of a healthy tree will not appreciably detract from its ornamental value and may even improve it.

Without care such as has been described, native holly is not wholly satisfactory for the commercial production of holly greens. The quantity of greens that can be harvested annually from native holly is generally considerably less than the product of a comparable area of planted orchard in full bearing, but often the expense of production will be proportionately very much less. Growth conditions, however, can be improved to such an extent that holly alone will give appreciable returns on woodland areas where it occurs, and the improvement can be combined with the management, for timber production, of the other forest species that may be present.

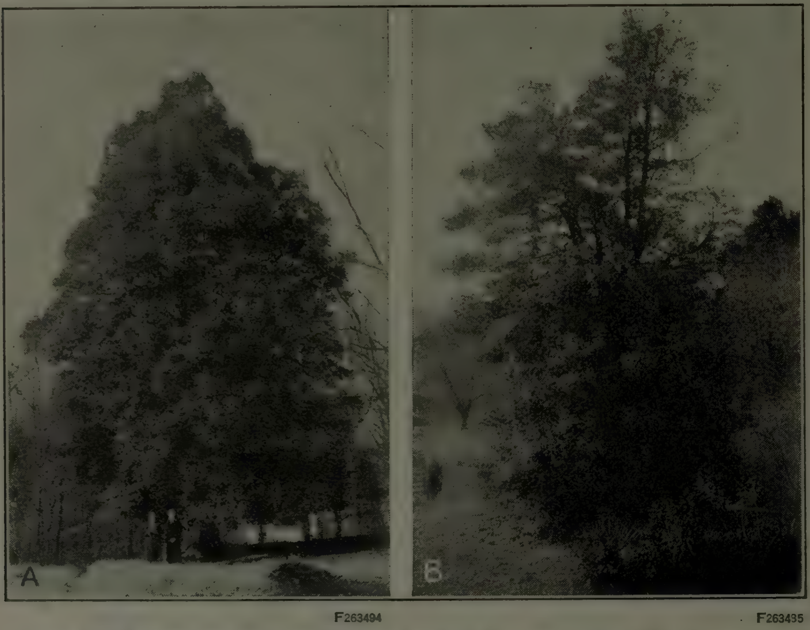


FIGURE 5.—Two American holly trees on an old Virginia estate. The trees stand about 75 feet apart and may have been planted before 1785, at which time the near-by house is known to have been in existence: A, A beautiful specimen about 45 feet tall and with a trunk 1½ feet in diameter; B, the deleterious effect of fire on holly. Heat from a near-by brush fire killed the lower limbs of this tree and caused root suckers and sprouts to develop and form the rounded mass of foliage at the base of the tree

OBTAINING HOLLY STOCK FOR PLANTING

WILD SEEDLING STOCK

In the southeastern and southern sections of the country small natural holly plants may occur in sufficient numbers to be used as transplanting or field-planting stock. Disadvantages of such wild stock include its great variation in age and size and the fact that many of the plants, though small, have developed such an extensive root system that many roots are lost in digging. An advantage, on the other hand, is that these plants may often be obtained for little or nothing other than the cost of digging and transportation. In general, wild seedlings will not prove very satisfactory for transplanting.

REPRODUCTION FROM SEED

Clean, dry holly seed can be bought from many seed dealers, at prices varying from year to year, or it can be collected by the grower. The seed is obtainable in the late autumn. Berries collected for seed should be taken only from vigorous, healthy trees. The seed should be separated from the pulpy portion by macerating the berries in water, after they have been gently crushed, until the seed is washed and freed from the pulp. The good seeds will sink in the water and can be collected.

Germination of seeds of the English and American hollies is very slow, usually extending over one year at least.

A seed bed should not be destroyed because no seedlings, or only a few, appear during the first season; many seeds do not germinate until the second, or even the third season after being planted.[3]

Holly seed can be planted at any time. However, little is gained by fall or winter sowing, as the seed usually does not germinate for a full year afterwards. Seeds sown in May have been found to germinate the following spring (a year later) in the same proportion as those planted six months earlier. Since so little is gained by fall planting, it is often desirable to hold the seed over for the spring planting, and for this purpose the seed may be stratified. It is not at all certain that stratification aids germination, but it is a satisfactory way to keep the seed moist, cool, and safe from molestation. For stratifying seeds, use a sound wooden box in the bottom of which two to four small drainage holes have been bored. Spread moist, clean sand an inch or two deep over the bottom, and on this place a thin layer of seed. Moist sand and seeds are then deposited in alternate layers. The box should be buried in soil in a well-drained, shaded spot out of doors and left until the seed is wanted for planting in the spring, at which time it is recovered by sifting the contents of the box through a screen or sieve of such a mesh that the sand is passed and the seeds retained.

Seeds may be sown in seed beds as soon as they are collected and cleaned, if the beds are protected from molestation. The irregularity of seed germination makes impracticable any statement as to the best density at which to seed beds. The ability of the seed to germinate, its size, and the number of seeds per pound will vary from year to year. One lot of dry clean seed of *Ilex aquifolium* contained 5,600 seeds per pound, about 5 per cent of which were obviously infertile.

Seed may be sown broadcast or in rows, in well-prepared soil. It should be sown rather sparsely and covered with not more than half an inch of soil. For the first two years seedlings seem to do best under partial shade, such as occurs on the north side of a building or hedgerow, or under a low frame to which parallel laths, spaced an inch apart, have been nailed. To conserve soil moisture it is well to cover the seed bed with an inch of compost or thoroughly rotted manure (as free as possible of ammonia), which has been finely divided and freed of lumps.

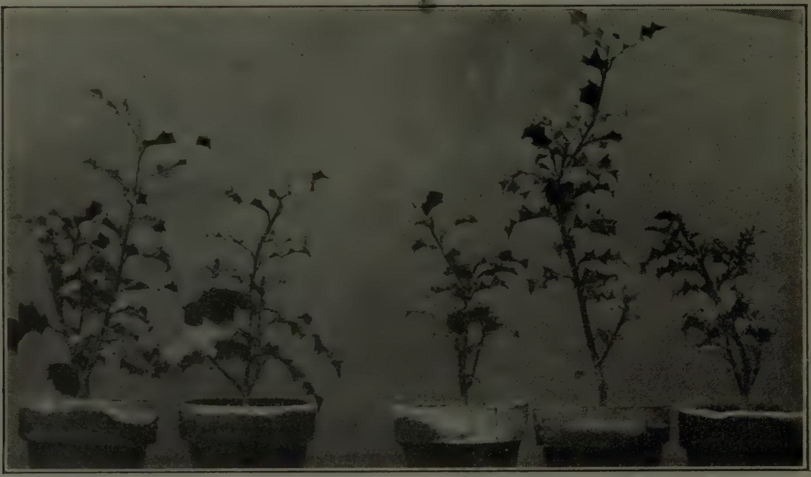
---

[3] Though it has been stated that germination may be hastened by placing seeds in a 5 per cent sugar solution and putting them under heavy pressure, such a method is not generally practicable because of the cost of the necessary equipment and experimentation. Treatments with boiling water, sulphuric acid, and caustic compounds have been tried but have not proved very successful.

Seed beds do not demand a great deal of attention but should be protected and kept free of weeds and grass. During dry periods they should be watered. After one or, at the most, two years, the plants do not appear to need shade.

VEGETATIVE PROPAGATION

Holly may be propagated by means of cuttings, layering, or grafting. Propagation by layers or cuttings has a distinct advantage over reproduction by seed. Plants resulting from cuttings or other vegetative means of reproduction run true to type, that is, they have the characteristics of the plants from which the cuttings came. A plant developed from a cutting, scion, bud, or layer of a female or berried plant or branch can, therefore, be counted upon to produce berries and to have the leaf and other characteristics of the parent. The grower can thus favor the propagation of female trees, whereas by seed reproduction a preponderance of male trees is grown. (Fig. 6.)



F239288

FIGURE 6.—Rooted cuttings of English holly 1½ years old. The three cuttings on the right are from "berried" stock

If maximum returns are to be obtained from plantations, particularly of select English holly, it is essential that the most vigorous, attractive, and rapid-growing stock be obtained. Uniform stock of this character can be reproduced only by vegetative propagation, details of which are given in Farmers' Bulletin 1567, Propagation of Trees and Shrubs.

LAYERING

The method of propagation known as layering is rather cumbersome where large numbers of plants are desired, and requires considerable ground space. In this process a stem of an established plant is bent down to earth and a portion of it covered with soil, but the tip of the branch is left exposed. Roots develop from the buried portion. A small cut, one-third or more of the way through the underside of the stem where it is buried, usually encourages the development of roots. When well-established new shoots and roots have developed (usually by the end of a year), these new shoots, complete with their roots, can be severed from the parent stem. The new plant should, however, be left in place in the soil for another year before it is transplanted. This method is used for reproducing English holly and some of its varieties in the Pacific Northwest.

CUTTINGS

Propagating holly by cuttings has not been universally successful, and it is not recommended that the inexperienced person attempt to use this method extensively without first experimenting with it. Experiments carried out by P. L. Ricker (Wild Flower Preservation Society and United States Department of Agriculture cooperating) and others, and a report by Zimmerman and Hitchcock[4] suggest the following facts that should prove helpful in propagating hollies by means of cuttings:

A medium of one-half sand and one-half peat moss by volume, or 3 inches of sand over 1 inch of sphagnum moss, is good for holly cuttings (indicating that hollies need acid soil).

Cuttings of evergreen hollies usually will not root when all the leaves are removed.

Four to six inch cuttings of current wood only are better than those with 4 to 5 inches of current wood plus a portion (or heel) of 2-year wood, though the latter are fairly satisfactory.

Though some cuttings might root in as short a period as three weeks, most of the cuttings will not root in less than three or four months.

For most practical purposes a daily temperature range of 65° to 75° F. is satisfactory, though temperatures 10 degrees lower at night are not harmful.

Cuttings may be taken from parent stock from October to December.

Cuttings should be set firmly about 3 inches deep in the soil.

Dormant cuttings may root satisfactorily, but the buds may not develop into shoots until the rooted cuttings have been stored in a cool place for two months or more.

GRAFTING

Some nurseries prefer grafting in the spring and budding in the summer to propagating hollies by cuttings, since grafted stock raised in greenhouses or frames produces plants which reach salable size more quickly. Inasmuch as this difference in size tends to disappear after a few years, this particular reason for grafting has a value more apparent than real to the holly orchardist.

Grafting has been of greatest value in the reproduction of individual ornamental hollies, but occasional owners may desire to experiment with male trees top-worked with female fruiting scions to make these male trees bear fruit.

The common whip graft is satisfactory for grafting English holly and its varieties.

Grafting demands special experience and equipment and can not be recommended for unrestricted use by the untrained holly grower. Holly can be successfully grafted and budded, but it will pay the average owner to buy grafted stock or to hire an experienced propagator to top-work seedling stock that has reached a suitable size in a plantation; or, preferably, to reproduce his female stock by layering.

---

[4] American Journal of Botany, volume 16: Vegetative Propagation of Holly.

BUDDING

Shield budding may be used to reproduce hollies but, like grafting, requires a certain skill if satisfactory results are to be obtained.

TRANSPLANTING

Transplanting of holly is considered to be difficult but should be successful in the majority of cases where the procedure outlined below is followed and the work is carefully done.

When holly plants are two years old they should be transplanted, in rows, to new ground. Plants should be spaced about 1 foot apart in the rows; the distance between rows depends on the method of cultivation to be used—that is, whether it is to be done by hand, horse, or tractor. The plants, particularly if grown from seed, can remain so spaced for two or three years, after which time, if still larger plants are desired, they can be retransplanted 2 feet apart and left for two years more. Plants from vegetative propagation are often big enough to be set out in the field after the first transplanting. (Figs. 7 and 8.)

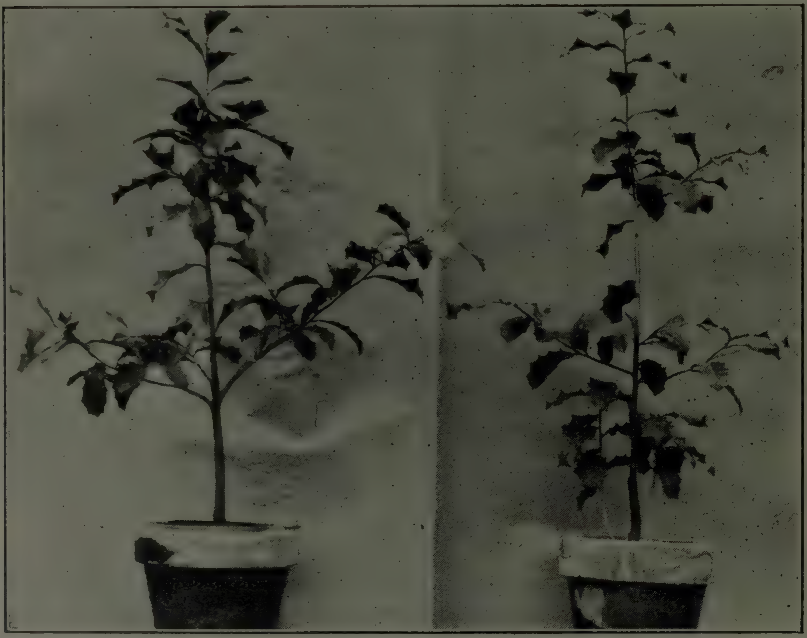

F239290

FIGURE 7.—Rooted Cuttings of American holly 4½ years old

Transplanting in quantity can best be done at the end of the growing season in the fall or just before the start of growth in the spring, though it is possible to move a holly tree with a sufficient ball of dirt about the roots at almost any time. In parts of the Pacific Northwest much of the transplanting is done in October. In other sections planting in the spring would seem preferable, though opinions differ upon this point. In the most southern tier of States transplanting may be successfully practiced at almost any time during the winter.

During transplanting the roots should not be exposed to the air long enough to dry out even partly. Exposed roots may be covered with moist soil or wet burlap, or plants for the planting crew can be kept at hand in pails containing wet sphagnum moss or leaves. Plants can also be moved with a ball of soil about the roots. Though this is a somewhat costly method, greater survival may be achieved in the final plantation.

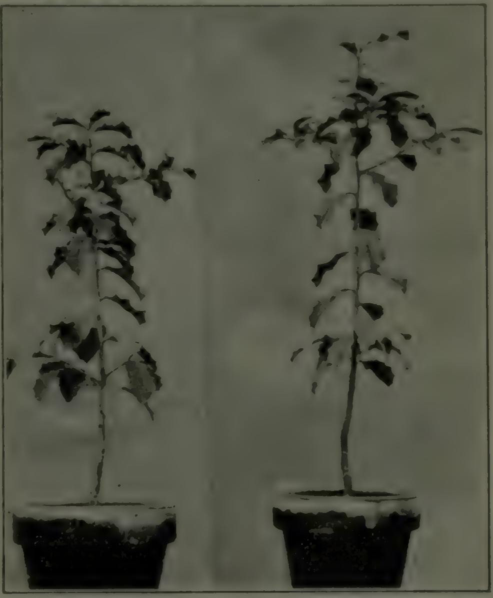

F239289

Figure 8.—Seedlings of American holly 4½ years old. Note the greater vigor and size of the rooted cuttings shown in Figure 7

Transplanting usually causes some injury or loss of roots and results in a check to the plant functions, placing the plant somewhat at a disadvantage in procuring moisture and nutrients from the soil, particularly if a dry period follows the transplanting. Hence, when plants are set out it is good practice to remove a few or nearly all of the leaves in order to reduce loss of moisture. Even if this is not done, there is usually a natural fall of leaves which may achieve the same end, though after some delay. If leaves of newly planted hollies shrivel but do not fall, the plants should be immediately pruned to reduce the foliage, or shaded from the sun, or both. A mulch of compost, decayed leaves, or well-rotted manure applied to the ground above the roots after transplanting is usually desirable to conserve soil moisture. During very dry periods transplants should be watered, at least for the first year or two.

DETAILS OF ESTABLISHING THE PLANTATION

GENERAL CONSIDERATIONS

Pure plantations of holly on open land, rather than planted in woodlands, offer a more intensive means of producing greens, and though costs of managing them are greater than for comparable areas of wild holly, the returns may be proportionately greater. Less attention is required by the holly plantation than by most field crops, and labor can be supplied at times when there is the least other farm work to be done. Improvement of woodland areas containing holly can be carried out during the winter. Planting can be done before spring plowing. Holly greens are harvested a few weeks before the Christmas-holiday season. Part of the cultivation of some of the more intensive plantations comes during the growing season, but the exact time of cultivation is not so critical as that of field crops. Some plantations in the West may be cultivated only once a year, just after harvest time.

CULTIVATION

It is best to prepare and cultivate a site for holly as for any fruit orchard. Holly plants need very careful treatment and good conditions when first set out. After the original plowing and planting, it is not essential to cultivate more than enough to keep weeds and grass from around the newly planted trees until they are reasonably well established. Cultivating the soil naturally results in greater thriftiness and more rapid growth of the trees and consequently makes possible an earlier return from the plantation. If soil acidity must be promoted, it may be best to leave undisturbed leaf litter or a mulch of similar material about the base of the trees rather than to practice complete cultivation.

SOIL FERTILITY AND FERTILIZER

Upon soils of low fertility holly trees will usually be unable to make the good twig growth or to produce the large berries needed for the best financial returns. Removing quantities of material from the trees necessitates proper attention to soil fertility, as in any orchard, if the yield is to be kept high. Though common farm manures, commercial fertilizers, and cover crops can be adapted to holly orchards, the holly grower should ascertain the particular requirements of his land by various treatments of single trees or groups of trees for a year or two before applying a single treatment to the whole orchard.

In western Washington soil fertility and the soil's water-holding capacity are said to be in need of attention before the best growth can be obtained in holly plantations.[5] Manures are capable of both adding fertility and improving moisture conditions. The author of the publication cited recommends a trial of various treatments, as mentioned above, and suggests the following treatments for consideration:

Manure (horse and cattle), 6 to 8 tons per acre.

Manure (chicken litter and sheep), 4 to 5 tons per acre.

Commercial fertilizer (5 per cent nitrogen, 10 per cent phosphoric acid, and 7 per cent potash or thereabouts), 1 pound per transplant or 6 pounds per mature tree, worked into the soil about the trees.

Superphosphate, 300 to 400 pounds per acre to supplement manures (often beneficial).

Cover crops (40 pounds of common vetch and 70 to 80 pounds of rye per acre, to be turned under by spring plowing).

SPACING THE TREES

The spacing adapted to the final planting of a holly orchard is determined by the species used, the factors affecting growth, and the manner in which the holly is to be clipped when it comes into bearing. Though hollies will stand an appreciable amount of shade, they should not be spaced so that they will crowd one another when they reach producing size unless some trees are to be removed by thinnings. Crowding seriously hinders harvesting of the foliage and tends to reduce the production of foliage in the lower portions of the tree in favor of the upper portions, which are not so easily reached.

---

[5] Western Washington Experiment Station Bulletin 7–W: The Culture of Christmas Holly.

Trees 3 to 7 years old may be planted with a square spacing of 20 to 25 feet each way or may be placed 15 to 20 feet apart in rows 20 to 25 feet apart. If the latter system is used, most of the foliage will be clipped when the trees get large by working down each side of a row and not by attempting to harvest much material from between the trees after the first few years. In the Northwest spacings of 25 to 27 feet each way are recommended. Small trees planted with such wide spacings as those suggested above appear unnecessarily far apart. As the trees increase in size, however, the reason for the wider spacing becomes apparent. When the maximum harvest is reached the trees will occupy almost as much of the ground as is compatible with ease of harvesting, and they will still be growing.

Small holly trees can be planted two, four, or even eight times as densely as recommended in the preceding paragraph if the owner will make adequate thinnings later on before the trees begin to crowd each other. Such thinnings will be absolutely essential for the final success of the plantation. The smaller trees removed in thinnings can often be dug up and sold as live plants or cut out and trimmed to yield the maximum amount of greens. This will bring in considerable revenue before residual trees (saved for the final stand) are large enough to withstand trimming for greens.

The number of trees per acre needed for any spacing can be determined by dividing 43,560 (number of square feet per acre) by the product of the spacing in feet in two directions; i. e., spacing 15 by 25 feet equals 375 square feet per tree or (43,560 divided by 375) 116 trees per acre.

In open woodlands holly should be so planted as to utilize as well as possible the openings that exist. Where these openings are extensive, holly can be planted with a uniform spacing; but where the openings are small, only one or a few trees should be planted in each. Holly grows so slowly when shaded that planting it under the crowns of other trees can not be recommended.

PLANTING RECOMMENDATIONS

Protect roots from injury or loss.

Prevent drying out of the roots, especially from exposure to the air, sun, and wind.

If planting is followed by a dry period, water the trees sufficiently to insure their survival. A mulch about the base of the trees is helpful in conserving moisture.

In all planting operations (and this includes transplanting) dig holes large enough to receive the roots in a natural position without cramping.

Plant female, rapid-growing, berry-producing stock when possible. Holly sprays with berries bring greater returns than sprays without berries. The holly grower should therefore strive to establish a plantation in which female or berry-producing trees greatly predominate.

SPECIAL CAUTION

Do not destroy all male trees, since individuals scattered among the female trees are needed to furnish pollen and insure development of the berries. The exact proportion of male to female trees necessary for best results can not be stated definitely, but 1 male to 10 female trees should prove satisfactory if the male trees are uniformly distributed.

It is reported by the Western Washington Experiment Station that Dutch and common English holly trees apparently mature some fruits without the introduction of pollen, but that certain select English holly trees produced practically no fruit during 1930 and 1931 unless pollen was supplied by male trees.

HARVESTING HOLLY

Harvesting may begin in 12 to 20 years if the trees appear thrifty and are well clothed with foliage. The operation may begin about December 1, or even sooner, and continue from one to two and a half weeks or more, depending upon market outlets for the material and how far it is to be shipped. Sprays cut too early will become too dry, and will be unsatisfactory, by Christmas. Though some of the younger English holly trees (20 to 25 years old) will yield as much as 35 to 40 pounds of foliage without being injured, they should not be trimmed too heavily. Trees should be left in good condition for recovery and growth. If they are not trimmed too heavily, they will increase their size and the amount of foliage more rapidly and return larger yields later.

Leaders or the actual tips of strong side branches should not be harvested or pruned from young trees, for the tip buds, which would be removed, are needed for making yearly growth in length. Cutting should be from the sides of branches and 2 or 3 inches of each twig should be left in place. This portion that remains usually has several buds which will give rise to more material the following year. When the trees are as big as is desirable, ends of main branches and leaders can be cut to keep the trees from getting larger.

Some older trees of English holly will bear fruit only in alternate years if they are allowed to become dense and to bear heavy crops of berries. The lower limbs may become too heavily shaded. Pruning, in addition to the annual trimming, is often desirable, opening up the crown a little to encourage an annual berry crop and to benefit the lower parts of the tree.

Holly branches are easily collected by spreading a canvas near the trees and dropping the sprays upon it as they are clipped, or by dropping sprays into large baskets or hampers. Such methods are essential if the ground is wet or snow covered and the sprays themselves are dry. If possible, sprays should be collected only when they are dry.

Holly must not be shipped while wet on the outside, because it will mold or sweat; this causes the leaves and berries to become discolored or to drop off. The cut sprays are therefore spread on trays to dry (drive off the external moisture), but the drying room must be kept cool.

While some cutting, thinning out of trees, and trimming that will help reduce the overhead expenses can be done in a holly orchard before it comes into real production, owners should expect to wait 12 to 20 years after planting before they will receive an appreciable financial return.

TRAFFIC IN CHRISTMAS HOLLY

In late years the center of production for American holly greens has been in the coastal portions of Delaware and Maryland, although considerable quantities of greens are produced as far south as North Carolina. The center of production is definitely moving southward, Maryland having only recently supplanted Delaware as the leading producer.

In view of this southward trend, it is well to call attention to the fact (discussed later under Shipment of Holly) that packed wreaths have been found to deteriorate or discolor in transit at temperatures of 50° F. or higher. Although branch holly is being successfully shipped from the North Carolina coast line, the production of wreaths in regions south of Maryland should be entered into with caution, since the frequent high temperatures are very likely to affect shipments in standard commercial cases.

Relatively small quantities of English holly are shipped from the Pacific Northwest. The Western Washington Experiment Station estimates that there are about 30 acres of holly now in bearing in western Washington, that 100 acres more will be in bearing within five years, and that there are enough trees in nursery rows to plant 450 acres more; altogether enough, when in full bearing, to produce some 350 tons of greens annually.

It is estimated that in an average year 10,000 persons in the eight southern counties on the Eastern Shore of Maryland engage in harvesting holly, and obtain an annual income of $150,000 from this source.[6] (Fig. 9.) An entire family usually engages in the industry. Approximately 10,000 boxes of holly are shipped annually. A survey made a few years ago in Delaware[7] indicated that holly products valued at approximately $400,000 were shipped annually from the lower counties, and that about $100,000 was received by those, mostly small farmers, who gathered sprays and made up wreaths. The annual shipment was estimated at 7,000 cases containing some 1,500,000 wreaths and 600 cases containing loose sprays and branches.

American holly wreaths are usually 10, 15, 24, or even 36 inches in diameter. The 10-inch wreath is the most common. The wreath framework is comprised of wires, or withes of various hardwood species, formed into a hoop of appropriate diameter, with the holly sprays bound to it. Bulk holly usually consists of sprays 2 to 3 feet long. Wreaths and bulk holly are usually shipped in standard holly boxes, 2 feet square on the ends and 4 feet long, built of thin lumber. A few paper cartons are now being used. (Fig. 10.)

---

[6] Information on the holly industry on the Eastern Shore furnished by K. J. Seigworth, a district forester of the Maryland Department of Forestry, stationed at Salisbury, Md.

[7] Report of Commission for the Conservation of Forests in Delaware to the Delaware General Assembly of 1927.

Because many inquiries as to the prices paid for holly greens have been received, it has seemed desirable to include information on this point. It should be emphasized, however, that prices quoted for a given year and place are not necessarily applicable in other years and to other localities. In 1926 persons in Delaware who made up wreaths at home and sold them in small lots on the open market are said to have received 5 to 20 cents apiece for them. In Maryland, during 1930 and 1931, local retailers paid approximately 15, 25, and 55 cents for 10, 15, and 24 inch wreaths, respectively. Bulk holly in the standard-sized boxes brought pickers about $2 per box. The boxes themselves cost from 50 to 75 cents apiece. Apparently prices for holly in Maryland during 1931 did not decline appreciably from those of 1930, although the demand decreased about one-half. Under normal conditions the poorer grades of English holly sprays brought

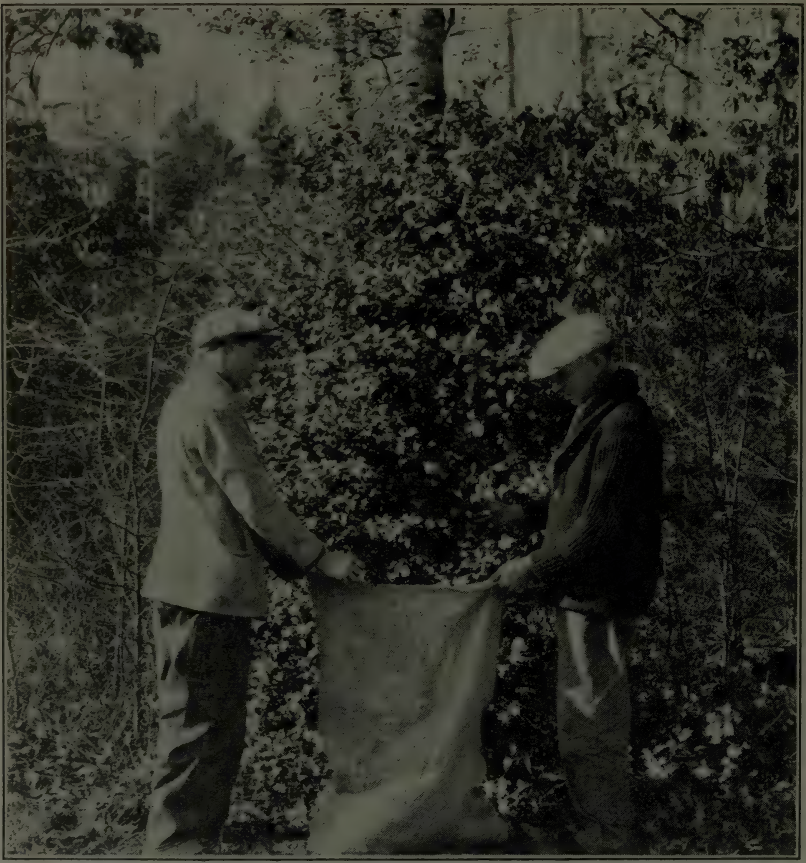


FIGURE 9.—Harvesting wild American holly, Sussex County, Del.

growers in the Northwest 15 to 20 cents a pound. The better grades brought 30 to 35 cents a pound. The 1-pound holly gift packages have sold for as much as 50 or 60 cents each.

SHIPMENT OF HOLLY[8]

The standard boxes for the shipment of American holly are lined with newspaper and packed with wreaths or bulk holly. The usual number of wreaths is 17 dozen per box, which means that they are packed very tightly. A box when packed will weigh from 110 to 125 pounds. Wreaths with natural berries are packed in different boxes from those with artificial berries.

Packages commonly used for sprays in the Northwest are of two sizes. One contains 10 pounds of holly net, and the other 1 pound gross. The former is used for bulk shipment and the latter for gift packages. Gift packages are lined with colored wax papers. Wreaths are packed in cartons.

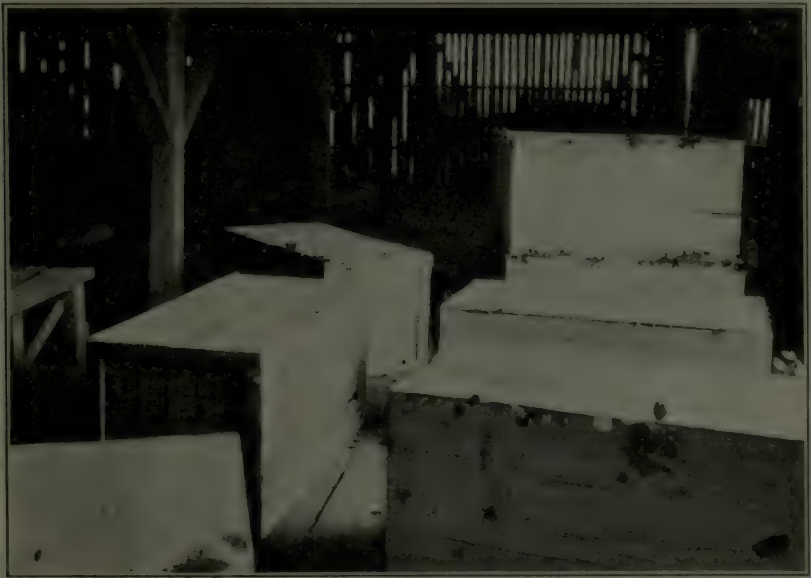


FIGURE 10.—Cases of American holly wreaths and sprays ready for shipment from Delaware

The shipping season in the East may begin as early as November 20 for the most distant points, to which shipments are made by freight. Express shipments begin about December 1 and cease about December 20 with shipments to near-by points. A considerable amount of holly is also moved by truck. Freight shipments often move in carload lots, one car holding approximately 166 cases.

Often, instead of showing the desired fresh, green condition upon arrival at its destination, holly shipped in boxes shows a bronze-green, brown, or blackish discoloration of the leaves that markedly reduces its salability. Investigations by representatives of the Department of Agriculture indicate that:

---

[8] For further information of value to those contemplating the commercial shipment of holly branches or wreaths see Department of Agriculture Circular 207, The Deterioration of Christmas Holly in Transit and Storage.

(1) Freezing or harvesting and shipping holly in a frozen state, does not directly cause discoloration of the leaves.

(2) Holly stored at 32° to 40° F. suffers little discoloration, while at 50° and more it discolors proportionately as temperatures are increased.

(3) Berries do not discolor except when mechanically injured.

(4) Holly superficially wet discolors more when stored at temperatures of 50° F. or higher than does dry holly.

(5) In warm "muggy" weather boxes of holly tend to heat and discoloration is likely to result, hence at such times wreaths should not be packed in boxes too far ahead of shipping schedule unless the inside temperature of the boxes can be kept at least as low as 40° F.

It is mentioned under Harvesting that holly sprays should be superficially dry before shipment. Dry, frozen sprays of holly in shipping boxes will condense moisture from the atmosphere when the boxes are exposed to warm moist air. Since dampness favors deterioration, it is as important to prevent moisture condensation as it is to make sure that sprays are superficially dry before they are packed.

MARKETING HOLLY

Producers and growers of holly would do well to make all arrangements for marketing their product before they begin harvesting. Such arrangements should include details as to (1) time and place of delivery, (2) the basis and time for payment, (3) the size and kind of sprays most desired by the buyer, and (4) the total quantity.

Many growers roughly grade their holly. The better holly sprays are those 6 inches or more in length with a goodly number of berries and leaves that are healthy and of a good color. The second class or grade includes shorter sprays, with or without berries, with leaves that are less attractive. The second grade is used for wreaths, together with a few berried sprays of the better grade. Wreaths, therefore, offer an outlet for male sprays and others that are not of the very best quality.

The possible markets for holly are numerous. Many growers can dispose of holly locally to wholesale grocers, florists, merchants at public markets, and persons who conduct open-air stands for the sale of Christmas trees just before the holidays. If local requirements have already been filled, similar agencies in other cities and States should be tried. In many sections making holly Christmas wreaths is a business. Holly can sometimes be sold to those who make wreaths, or, where safe shipping conditions are assured, the grower can himself undertake to make wreaths and market his holly in that form, through the channels mentioned above.

In recent years a large number of small potted conifers have been sold as "living Christmas trees." It seems probable that the sale of small potted holly trees would be as successful, or even more so. The English holly has a marvelously rich foliage and small potted plants of it would lend much charm to any home at Christmas.

Artificial holly berries are on the market at the present time. While it is not recommended that these be used in preference to live berries, the artificial berries can be attached to male holly sprays, plants, and wreaths, greatly improving their attractiveness and making them more marketable.

The life of the holly trees can be measured in centuries. Although the owner of a plantation may have to wait 12 to 20 years after its establishment before he receives an income from it he finally achieves a practically permanent asset.

OTHER HOLLIES AND HOLLY-LIKE PLANTS

According to Standardized Plant Names, 12 additional species of true holly (Ilex), 11 varieties (9 of which are varieties of the English holly), and 1 hybrid holly are commonly recognized horticulturally. These are: Chinese holly, *Ilex cornuta;* common winterberry, *I. verticillata;* coral holly, *I. corallina;* dahoon, *I. cassine;* finetooth holly, *I. serrata;* Golden Queen holly, *I. aquifolium aureo-regina;* hedgehog holly, *I. aquifolium ferox;* Hodginson holly, *I. aquifolium hodginsoni;* inkberry, *I. glabra;* Japanese holly, *I. crenata;* laurel holly, *I. aquifolium laurifolia;* littleleaf holly, *I. aquifolium microphylla;* littleleaf Japanese holly, *I. crenata microphylla;* longstalk holly, *I. pedunculosa;* mountain winterberry, *I. monticola;* possumhaw, *I. decidua;* pyramid holly, *I. aquifolium pyramidalis;* sawtooth holly, *I. aquifolium serratifolia;* smooth winterberry, *I. lævigata;* Topel holly, *I. vomitoria × opaca;* variegated English holly, horticultural variety of *I. aquifolium;* weeping holly, *I. aquifolium pendula;* yaupon (cassena), *I. vomitoria;* yellow winterberry, *I. laevigata herveyi.*

Dallimore, in Arboretum Notes: The Hollies, or Species of Ilex, in the Quarterly Journal of Forestry for April, 1926, describes in some detail 13 species of Ilex, and 7 probable hybrids, and lists more than 50 varieties of *Ilex aquifolium.* The varieties are grouped according to whether they have normal green leaves, green deformed leaves, or golden or silver leaves.

Other species of plants which are often locally referred to as holly are: Christmasberry or toyon (*Photinia salicifolia,* syn. *Heteromeles arbutifolia*), Oregon hollygrape (*Odostemon aquifolium,* syn. *Berberis aquifolium*), seaholly (*Eryngium maritimum*), deserthoIly (*Atriplex hymenelytra*), and mountain-holly (*Nemopanthus mucronatus*).

The Christmasberry, or toyon, which grows abundantly on the wild lands of the foothill region in California, is harvested in large quantities at Christmas time. It is sometimes called holly. Its evergreen foliage and bright red (sometimes yellowish) persistent fruit make it almost as decorative as holly, in place of which it is often used. Destructive harvesting and fires may some time decrease its abundance to such an extent that it will pay to protect from fire and furnish cultural treatment (such as thinnings) to areas containing Christmasberry. Just at present it is doubtful whether cultivation of Christmasberry would result in profit unless such cultivation produced a superior quality that would command a better price than does the wild stock.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	Arthur M. Hyde.
Assistant Secretary	R. W. Dunlap.
Director of Scientific Work	A. F. Woods.
Director of Regulatory Work	Walter G. Campbell.
Director of Extension Work	C. W. Warburton.
Director of Personnel and Business Administration.	W. W. Stockberger.
Director of Information	M. S. Eisenhower.
Solicitor	E. L. Marshall.
Bureau of Agricultural Economics	Nils A. Olsen, *Chief.*
Bureau of Agricultural Engineering	S. H. McCrory, *Chief.*
Bureau of Animal Industry	John R. Mohler, *Chief.*
Bureau of Biological Survey	Paul G. Redington, *Chief.*
Bureau of Chemistry and Soils	H. G. Knight, *Chief.*
Office of Cooperative Extension Work	C. B. Smith, *Chief.*
Bureau of Dairy Industry	O. E. Reed, *Chief.*
Bureau of Entomology	C. L. Marlatt, *Chief.*
Office of Experiment Stations	James T. Jardine, *Chief.*
Food and Drug Administration	Walter G. Campbell, *Director of Regulatory Work, in Charge.*
Forest Service	R. Y. Stuart, *Chief.*
Grain Futures Administration	J. W. T. Duvel, *Chief.*
Bureau of Home Economics	Louise Stanley, *Chief.*
Library	Claribel R. Barnett, *Librarian.*
Bureau of Plant Industry	William A. Taylor, *Chief.*
Bureau of Plant Quarantine	Lee A. Strong, *Chief.*
Bureau of Public Roads	Thomas H. MacDonald, *Chief.*
Weather Bureau	Charles F. Marvin, *Chief.*

U. S. GOVERNMENT PRINTING OFFICE: 1932

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

Ind

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1694

Rev Aug 1940

DRESSING AND PACKING TURKEYS FOR MARKET

THROUGH FAILURE to kill, dress, and market their turkeys according to the best methods, turkey producers as a rule do not receive as large a profit as they might.

This bulletin covers practically every phase of the approved methods used in the preparation of turkeys for market. It has been prepared as the result of several years of practical experience in poultry-packing plants and extensive study at terminal markets. By following its suggestions, producers may become as expert in dressing and packing turkeys as is the experienced plant operator.

Washington, D. C. Issued November, 1932

DRESSING AND PACKING TURKEYS FOR MARKET

By Thomas W. Heitz, *Associate Marketing Specialist, Division of Dairy and Poultry Products, Bureau of Agricultural Economics*

CONTENTS

Page
Losses through faulty methods 1
Shall dressing be done at home? 1
Care in handling live turkeys 2
Selecting turkeys for market 3
Feeding before killing 4
Equipment for dressing 5
How to bleed and kill turkeys 6
How to pick turkeys 8
How to clean the carcass 10
How to wrap heads 11
How to sew torn skin 12
How to remove crops 15
Precooling 16
Saving the feathers 17
Hauling to market 18
Grading 19
Weighing and shrinkage 19
Boxes and barrels 20
Box and barrel linings 22
Box making 23
Nailing and strapping boxes 24
Barrel packing 25
Marking the packages 25
Sharp freezing 26
Shipping invoices 27
Car loading 27
A final word 28

LOSSES THROUGH FAULTY METHODS

THOUSANDS OF DOLLARS are lost annually by turkey producers in the United States because of inferior quality of birds and faulty methods in dressing and packing. A producer often devotes much labor and expense to raising turkeys of fine quality and then, either through lack of knowledge or through carelessness, loses much of the profit he might have obtained by giving more attention to selecting, finishing, and preparing his turkeys for market.

SHALL DRESSING BE DONE AT HOME?

Whether it is more profitable for a producer to dress his turkeys or to market them alive depends upon local conditions. Dressing shrinkage from loss of blood and feathers is approximately 10 per cent. (Table 1.) The additional price obtained for the dressed turkeys, therefore, should be enough to pay for this shrinkage and for the labor involved in dressing.

For example, a 15-pound turkey will shrink nearly 1½ pounds in dressing. At 20 cents a pound this would amount to a dressing loss of 30 cents, or 2 cents a pound on the live weight of the turkey. If labor is hired, or if the producer dresses his own turkeys, 15 cents a head is a reasonable charge for dressing. This adds another cent a pound to the cost, making a total of 3 cents a pound. Added to this are the risk of poor dressing, the danger of spoilage, and the greater cost of packages than of live-turkey coops.

On the other hand, dressed turkeys can be shipped longer distances with much less shrinkage in weight than can live turkeys, and when properly packed, the dressed turkeys can be hauled to market with less danger of bruises and abrasions. With care and practice a producer can dress his turkeys as satisfactorily as can the country packer. The increased price per pound for the dressed turkeys will usually enable a producer to obtain a larger return from his turkey flock, especially if he does the dressing himself or if it is done by members of his family.

TABLE 1.—*Loss of weight caused by dressing turkeys, completely bleeding them, and removing all feathers*

Number of turkeys in each group studied	Young hens			Young toms		
	Average weight		Percentage shrinkage in weight	Average weight		Percentage shrinkage in weight
	Live	Dressed		Live	Dressed	
	Pounds	*Pounds*	*Per cent*	*Pounds*	*Pounds*	*Per cent*
25	8.24	7.37	10.56	13.92	12.47	10.42
25	9.12	8.22	9.87	16.16	14.50	10.27
25	10.15	9.18	9.56	18.2	16.44	9.67
25	11.03	9.98	9.52	20.3	18.47	9.01
Average shrinkage			9.83			9.77

Pinfeathers are a common cause of disqualification from the higher grades. These pinfeathers show more or less over the entire carcass but are more noticeable over the hips, along the inside of the wings, and over the abdominal region. On immature birds the pinfeathers barely protrude through the skin; it is impossible to remove them satisfactorily, so immature birds should not be chosen for killing. If the pinfeathers are an inch or so long, it is well to pull one of them out and examine it by squeezing the quill. If a dark, bloody substance is in the quill, the turkey needs more finishing; if the quill comes out practically dry, the bird is mature and will "pick clean."

If the bird is not fully developed and finished, it should not be killed, for the extra weight obtained by holding a turkey until it is matured and the extra price received for turkeys of higher grade well justify a producer in holding for later markets, even though the price per pound received at the later date should be considerably lower. As a rule, however, the January farm price for turkeys is almost as high as the December price, and the Christmas-market farm price, in 8 of the last 12 years, has been higher than the farm price at Thanksgiving. (Table 2.)

CARE IN HANDLING LIVE TURKEYS

A bruise on any part of the carcass is a cause for lowering the grade in which a turkey is placed. Turkey flesh is very easily bruised; the producer should keep this fact constantly in mind. Most of the bruises found on dressed turkeys are caused by rough handling before the turkeys were killed.

SELECTING TURKEYS FOR MARKET

Much of the loss to a grower caused by marketing undergrade turkeys can be avoided by care in selecting the birds to be killed. Merely to kill a certain proportion of the flock for the Thanksgiving market and hold the rest for the Christmas market is a careless procedure that causes heavy losses to the producer. A turkey grower should not market his turkeys before they are ready any more than a fruit farmer should harvest his crop before it is ripe.

The only way to select the turkeys that are ready for market is to examine each bird. The first requisite of a high-grade turkey is full fleshing. To ascertain the amount of flesh on the turkey, different parts of the carcass of the bird should be thoroughly examined. The amount of flesh on the breast can easily be learned by feeling along the keel bone. The breast should be broad and the bone so covered with flesh that it does not protrude to the skin. The back, hips, and other bones of the body should also be fully covered.

Gently blowing against the feathers will make the surface of the skin plainly visible. It should appear light in color with no dark meat showing through the fatty deposit under the skin. A dark, bluish appearance is a sure sign of inadequate finishing. The first fat of a turkey appears on the back in broad layers extending from the neck to the tail. Small streaks of fat next develop over the hips; then thin narrow strips appear along both sides of the breast about midway between the wing joint and the peak of the breastbone. If the turkey is fattened enough for market, these primary streaks of fat are connected by thinner layers so that the entire carcass is fully covered.

TABLE 2.—*Estimated average farm price, per pound, received by producers for live turkeys in the United States, November 15, December 15, and January 15, 1920–21 to 1931–32*

Year	Nov. 15	Dec. 15	Jan. 15	Year	Nov. 15	Dec. 15	Jan. 15
	Cents	*Cents*	*Cents*		*Cents*	*Cents*	*Cents*
1920–21	31.8	33.1	33.0	1927–28	30.8	32.3	29.8
1921–22	28.2	32.5	30.7	1928–29	31.2	30.6	28.2
1922–23	29.5	32.3	29.7	1929–30	27.1	23.5	23.7
1923–24	27.9	24.5	23.1	1930–31	20.1	19.9	21.6
1924–25	24.2	25.8	26.2	1931–32	18.3	19.4	18.0
1925–26	28.3	31.1	31.7				
1926–27	29.8	32.8	31.6	12-year average	27.27	28.14	27.28

When catching turkeys the movements should be slow and cautious, in order not to excite the birds. If excited they trample each other, causing large tears and bruises. Bruises on the breast are often caused by catching a turkey by the legs and then jerking the feet from under it, throwing the turkey forward on its breast and bruising it. The right way to catch a turkey is to seize it between the middle and upper joints of the wing, on the side opposite from where one is standing. (Fig. 1.) The thumb should be between the wing and the body of the bird and the fingers should be closed around the wing on the underside. A turkey held in this way will not bruise itself by flapping its wings, and is easily handled. The flesh around the bone of the wing should not be twisted or held too tightly, for either action may cause discoloration.

If it is impossible to handle a turkey by the wing, both feet should be seized at one time and the turkey lifted in such a way that the breast will not strike the ground. The legs should be caught below the knees, as a firm grip of the hand will bruise and discolor the fleshy part of the leg. The wire hooks sometimes used in catching turkeys are likely to bruise the legs and other parts of the body, as there is no way to control wing flapping until the turkey can be held with the hand.

A chute so constructed that the turkeys can be driven into it and then caught without trampling on each other is desirable on any turkey farm.

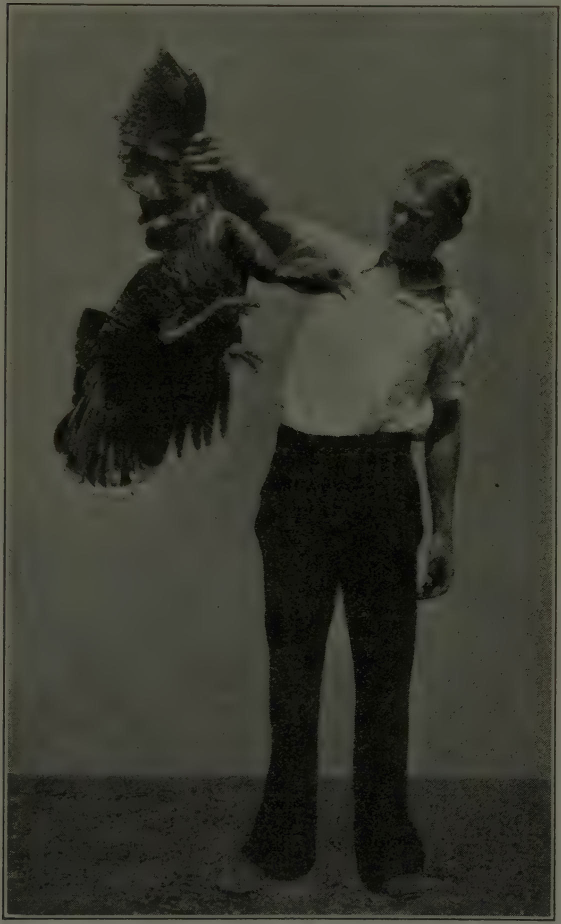


FIGURE 1.—The way to hold a turkey to prevent flapping. Many turkeys that would otherwise be of high grade are placed in lower grades because of bruises

FEEDING BEFORE KILLING

The question of the quantity of feed to be given turkeys immediately before they are killed is of great importance to a producer. If the crop contains feed after the turkey is killed, the entire crop must be removed or the grade of the turkey will be lowered. On the other hand, a bird starved too long before it is killed loses considerable weight.

A good plan is to feed the turkeys all the soft mash they will eat the evening before they are killed. If grain is given some of it may remain in the crops the following morning. As the soft feed is digested rather quickly the crops and entrails will probably be empty enough so that killing may start 10 or 12 hours after feeding. Before the killing is begun, however, the crops of the live turkeys should be examined by feeling each one to make sure that no feed remains in them. Water should be within reach of the turkeys constantly until the time of slaughter. When the flock is so large that some dressing in the afternoon will be necessary, the turkeys should be separated and those intended for afternoon slaughter may be given a light feed of soft mash very early in the morning.

EQUIPMENT FOR DRESSING

A properly equipped turkey farm requires a considerable financial investment, yet enthusiastic producers, when starting a turkey farm, will spend the necessary amount to care for rearing the stock and then fail to provide the right facilities for dressing. There is no excuse for using poor equipment or homemade tools when the producer can buy complete dressing equipment for less than $2 and the equipment can be used for several seasons.

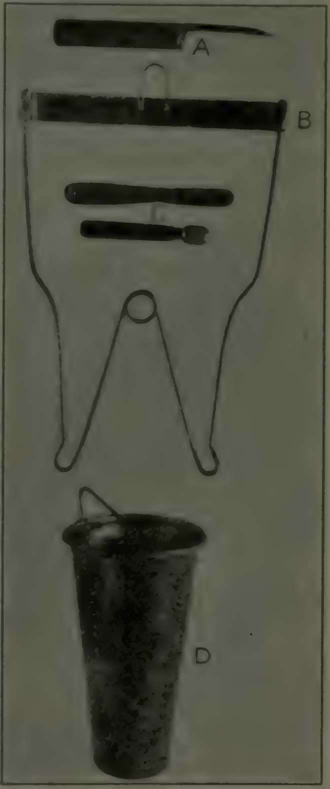


FIGURE 2.—Good equipment is necessary to a good job in dressing. Sticking knife (A), shackle (B), pinning knife (C), and blood cup (D) should be provided

A complete set of dressing tools for farm use consists of a sticking knife, a blood cup, a picking shackle, a pinning knife, and a needle for sewing torn skin. (Fig. 2.)

The sticking knife is the most important piece of the equipment. (Fig. 2, A.) Care should be used in buying it, as most knives sold by the produce-supply houses are designed for killing chickens and are not suitable for turkeys. A sticking knife for turkeys should have a thin, narrow blade at least 4 inches long, and a 5-inch handle. The blade should be made of the best quality steel so that it will retain its sharp cutting edge, and it should be thick enough not to bend. The cutting edge should be straight to the point, and the back of the blade should taper gradually to meet the sharpened edge. The blade should preferably be sharpened only 2 inches from the point.

Blood cups for turkeys should be 8 inches high and 4½ inches in top diameter. (Fig. 2, D.) The hook at the top should be so sharp that it will easily penetrate the tough skin of the head and neck. When buying a blood cup the weight should be given special consideration. If the cup is too light, it will not hold the head down; the turkey will swallow some of the blood, causing a discolored crop. If the cup is too heavy, the veins of the neck will be so stretched as to interfere with the flow of blood. For medium-sized turkeys the cup should be leaded to weigh from 3 to 4 pounds.

The picking shackle should be made of one-fourth-inch wire sufficiently strong to hold the feet in place while the turkey is flapping. (Fig. 2, B.) It should be so constructed that there will be a spread of at least 6 inches between the legs of the turkey, so that the feathers between the legs can easily be removed.

Various types of pinning knives, for use in removing the pinfeathers, are on the market, and choice of one is chiefly a matter of individual preference. The two types shown in Figure 2, C, have proved satisfactory. The blade of the knife should be dull, so as not to cut the skin or the feathers of the turkey, and the handle should be so made that it will not cramp the hand. A hole in the end of the handle through which a string can be run and the knife hung around the neck when not in use is a great convenience to the picker. The blade of the knife should not be over 2½ inches long.

A curved surgeon's needle is suitable for sewing torn skins. A No. 4 or No. 5 needle, depending on the size of the tear, will be satisfactory. The thread should preferably be of white silk, but No. 40 white cotton can be used. In case a surgeon's needle is not available, an ordinary sewing needle of medium size will serve the purpose.

HOW TO BLEED AND KILL TURKEYS

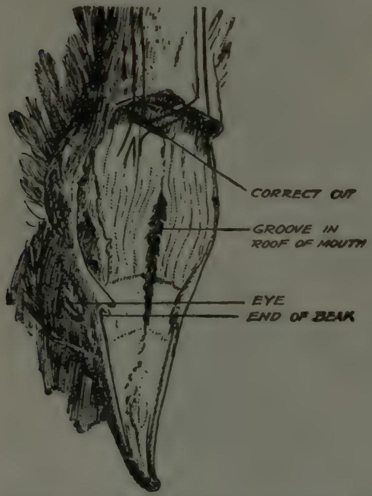


FIGURE 3.—The large vein and the cross vein should both be cut, and at the same time, to insure good bleeding

Bleeding and killing are simple operations. Any operator should be able to do them satisfactorily with a little practice. Bleeding and braining should both be done through the mouth. In bleeding, the operator should keep in mind the location of the veins in the neck. Two large veins run on either side of the neck, with a cross vein connecting them at the base of the skull, and form an outline somewhat like the letter H. The correct cut is one that will sever the main vein on the left side of the neck and, at the same time, the connecting vein. (Fig. 3.) In braining, the operator should keep in mind the exact portion of the brain to be pierced.

The turkey should be securely fastened in the shackle and hung so that the wings are on a level with the operator's elbows. The shackle should be hung far enough from the wall so that the turkey will not bruise itself when it flaps its wings. There is less likelihood of breakage if the wings are not locked. It is well to proceed slowly. The inexperienced operator is likely to excite both himself and the turkey; this prevents a good job.

Hold the handle of the knife loosely in the fingers and not in the palm of the hand. Grasp the head of the turkey by the bony part, and hold it firmly in the fingers of the left hand with the palm as far away from the head as possible so the operator will not be injured if the knife pierces through the head. With the thumb and forefinger press firmly on both sides of the turkey's head at the junction of the upper and lower beaks. This will cause the mouth to open so the knife can easily be inserted. (Fig. 4 A.) Hold the knife with the sharpened edge downward and insert it so the point will be at the base of the skull to the left of the operator. With a quick, light cut, press the point of the knife into the flesh, lifting the handle upward and cutting downward and to the right. The cut will be made with only the point of the knife. When the veins are properly severed in this way a heavy flow of blood immediately takes place; if this work is not correctly done, further cuts should be made until free bleeding is accomplished. Still holding the head with the left hand, insert the knife blade through the cleft in the roof of the mouth, sharp edge up (fig. 4, B), and thrust through into the base of the brain. The knife point should penetrate the back lobe of the brain (medulla oblongata) just below the eye. That part of the brain controls the feather muscles: when it is pierced the muscles relax and this loosens the feathers.

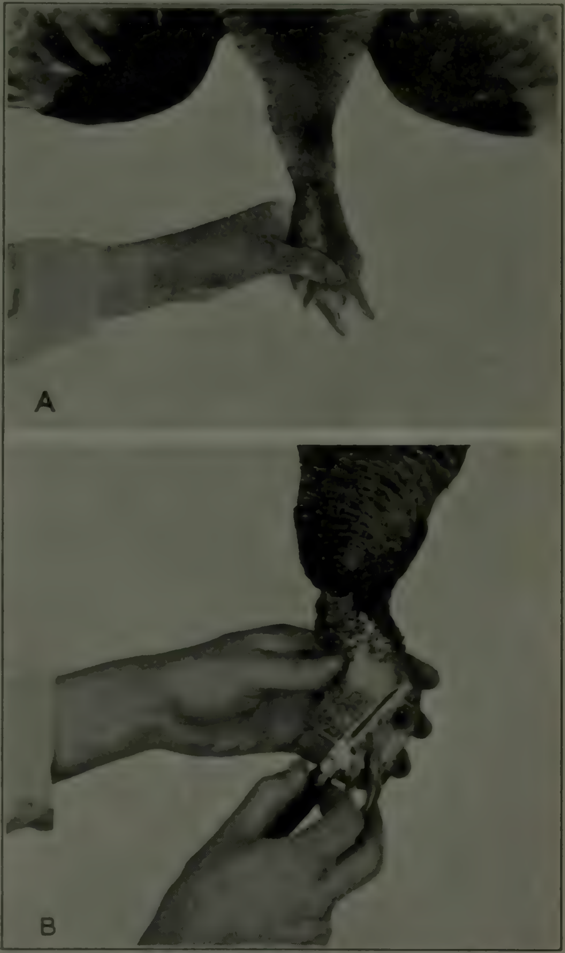


FIGURE 4.—A. Holding the mouth open preparatory to sticking. The knife blade must be correctly inserted to insure good bleeding. B. The direction the point of the knife should take to pierce the brain. Unless the brain is correctly pierced it will be difficult to remove the feathers.

If the brain is correctly penetrated, the turkey gives a characteristic squawk, the tail feathers spread, and a sharp convulsion of the body takes place. The feathers can then be easily pulled. If the brain has not been properly pierced, another attempt should be made.

If the turkey is very large or the knife blade is too small, in some instances not enough brain tissue will be destroyed to loosen the feathers if the usual method is followed. In such case the knife blade should be given a twist after the brain is reached; but this should be done with care, for if too much brain tissue is destroyed, heart action will stop, the bird will cease bleeding, and the flesh will harden and "set" the feathers.

Still holding the head downward with the left hand, fasten the blood cup at the base of the lower beak in such a way that the mouth will be held open. Do not relax the hold on the head until the blood cup is fastened, or the turkey is likely to raise its head and swallow some of the blood, causing a discoloration in the crop. Hold the turkey by the side of the head and not by the neck, for the pressure of the hand would close the veins and prevent good bleeding. As soon as the cup is fastened, begin picking.

HOW TO PICK TURKEYS

Hold the wings of the turkey back to back, with the left hand close to the body of the bird. Grasp the large tail feathers with the right hand, thumb down, and then turn the wrist and twist out the feathers as the fist turns upward. A single twist of the wrist should remove all the large tail feathers. (Fig. 5, A.)

The large wing feathers are next removed. The feathers of both wings may be grasped at the same time, thumb upward. (Fig. 5, B.) Jerk them out with a quick downward movement, using considerable force as they are harder to pull than the tail feathers. It may be necessary to take a second or third handful as it is difficult to grasp all the large feathers at one time, especially on large birds.

The breast and side feathers are removed next, beginning at the wishbone and working toward the legs. Seize the feathers with the whole hand, twisting the hand outward and in the direction of the slant of the feathers. A straight pull is likely to tear the skin. Work up to the thighs, twisting the feathers in each handful. (Fig. 5, C.) Finish one side of the turkey up to the leg, and then pick the opposite side before beginning on the legs.

In picking the leg, clasp it firmly at its base, thumb upward. Move the closed hand along, pressing just enough to strip the feathers. (Fig. 5, D.) Work in the direction of the feather setting, and strip only once. Do not wet the hands or clasp the leg too tightly, as either will injure the skin of the turkey. Pull any feathers left after the first stripping, for there are not enough feathers left to protect the skin from injury by the hand if the stripping were continued.

The operator is now ready for the back and hip feathers. He should grasp as many feathers in the hand as possible, and with a twisting motion rotate the forearm inward. Continue until the larger feathers are removed; then with thumb and forefinger pull out the small feathers between the shoulders. (Fig. 5, C.)

The neck comes next. Pick it by pulling against the slant of the feathers. (Fig. 5, F.) There is less danger of tearing the skin on the neck than on other parts of the carcass, but too many feathers should not be grasped at one time. Do not pick the neck or hip feathers until the bird is practically through bleeding or red blood marks will show on the skin.

The soft body feathers between the legs come next. They are easily removed if the picking shackle spreads the legs far enough apart.

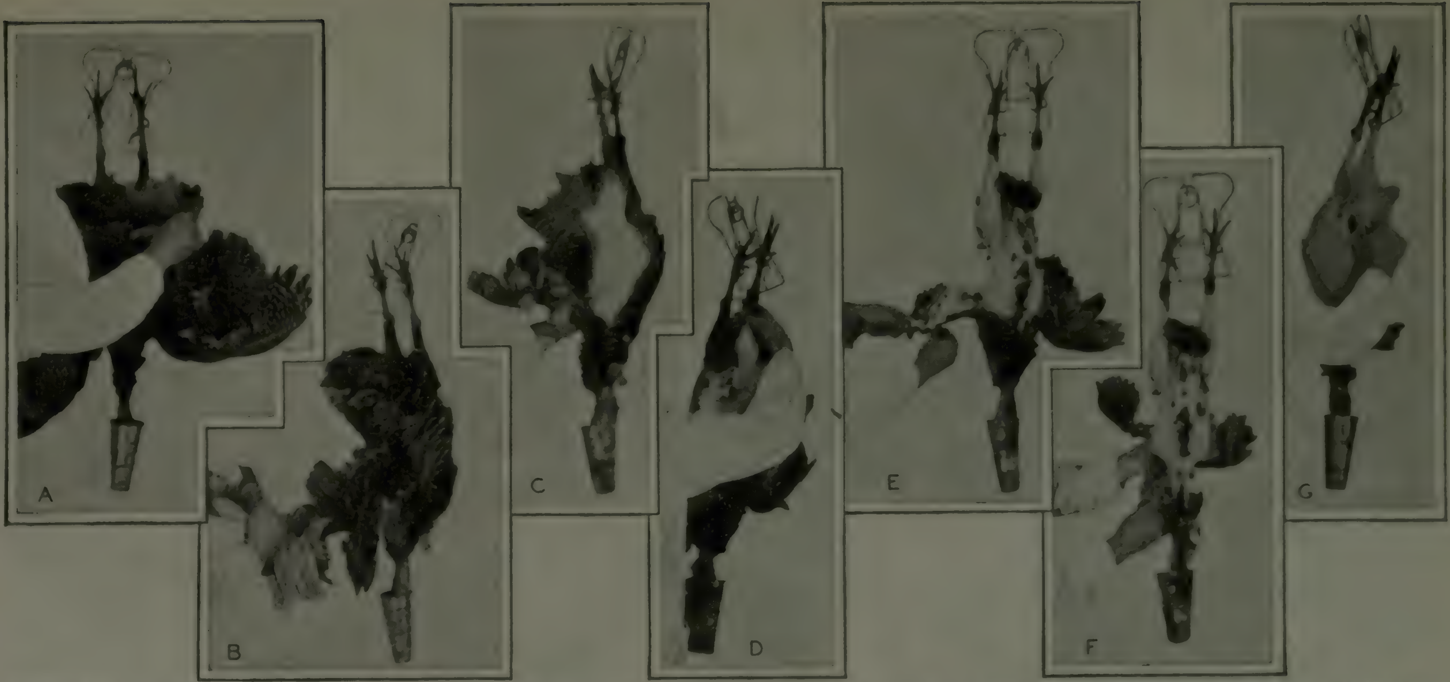


FIGURE 5.—A. In the picking operation the tail feathers are removed first. They should be twisted, as pulling them straight out is likely to tear the skin. B. The wing feathers may be pulled from both wings at one time, or each wing may be picked separately. C. Ready for the third step in picking. The feathers from one side have been removed and the operator is ready to begin on the opposite side. D. The fourth step is to remove the feathers from the legs. The legs should be stripped only once or the skin will be blistered. E. Removing the feathers from the back, hips, and wings. The smaller feathers are picked with the thumb and forefinger. F. Removing the neck feathers. The skin of the neck is tough and the feathers can be removed by picking downward against the slant of the setting. G. The last operation in picking. The pinfeathers can be easily removed when clasped between the thumb and pinning blade.

The small wing feathers come last. Stretch out the wing with the left hand and pick the medium-sized feathers on the outside. Pick only in small bunches, as the skin here is easily torn. The feathers from the inside of the wing are picked next; pull against the feather setting, using the thumb and forefinger. Pull the stiff feathers and fans one at a time by bending sharply downward and jerking quickly.

Too much time should not be given to removing the pinfeathers the first time over the carcass, as it is more important that the large feathers be picked as soon as possible after killing. The "roughing" job is usually done by the killer and the "pinning" job by less experienced help. In going over the turkey the second time (pinning) the pinning knife (fig. 5, G) should be used, as it is practically impossible to remove the small pinfeathers without some such device.

In some parts of the country the usual trade practice is to allow a single row of feathers, or fan, on each wing, and to allow a few feathers on the neck and around the knees. These serve no useful purpose, are insanitary, and must be pulled out before the turkey is cooked. It is therefore recommended that the feathers from the entire carcass be removed, with the possible exception of a single row of fan feathers on the wing tip.

HOW TO CLEAN THE CARCASS

By the time the pinner finishes removing the feathers the turkey has stopped bleeding and the carcass is ready to be cleaned. The first and most important part of the cleaning is to squeeze out the feces from the lower intestines. This is best done by pressing on the abdomen with the thumb just below the keel bone and moving the thumb toward the vent. The tail should be held back by the forefinger. The vent should then be sponged and any dirt or blood on any part of the carcass should be removed with the sponge.

A blood clot always forms in the mouth; this should be removed by "snapping" the head or by striking it sharply against some solid object. The head should strike the object near the base of the skull so as to permit the blood to fly out. This blood will usually scatter over the whole dressing room and is objectionable from a sanitary standpoint. Ae device such as shown in Figure 6 has proved satisfactory in avoiding this.

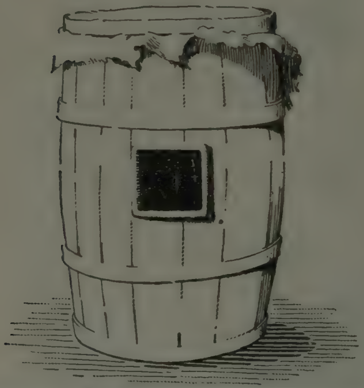


FIGURE 6.—A convenient arrangement for use in removing blood from the head. The turkey is swung by the feet so that the head strikes the edge of the opening, dislodging the blood which falls into the barrel

This simple device consists of a barrel with an opening, about 9 by 12 inches, in the side; usually the width of two wide staves sawed from the bilge will be sufficient. A burlap bag or other covering should be drawn over the top of the barrel. The edges around the opening should be covered, to protect the skin of the turkey from tears or bruises when it comes in contact with the barrel. Three or four thicknesses of burlap or a strip of rubber from the inner tube of an automobile tire will answer this purpose.

Hold the turkey by the feet and swing it so that the head will strike sharply against the edge of the opening in the barrel. The jar will cause the blood clot to loosen and fall from the mouth. The blood will be caught in the barrel and will not scatter over the room. After the head has been snapped, the mouth should be sponged, or wiped out with a cloth.

The turkey's feet are always dirty; if not cleaned they will soil the flesh of any birds packed in contact with them, therefore they must be washed. A tub of water (preferably warm) and a scrub brush are used. The operator usually sits on a stool near the tub. The turkey should rest on the left leg of the operator, breast down, and should be supported by the left elbow holding the carcass on the knee of the operator and against his body. In most cases three or four strokes of the brush across the bottoms of the feet will remove the dirt. The feet should then be wiped dry to prevent the dirty water from running down over the legs of the turkey when it is hung up to cool.

HOW TO WRAP HEADS

A good quality of waterproof paper should be used for wrapping heads. Brown, parchmentized, kraft paper, waxed on one side, is probably the best for this use. Blood does not show through brown paper as much as through paper of a lighter color, and the waxed surface prevents the blood from soaking through. The paper should be heavy, 40 pounds to the ream, and so cut that the waxed surface will be inside, next to the head, when the wrapper is put on. Newspapers or paper sacks are not satisfactory as head wrappers because they are seldom bloodproof and are hard to keep in place.

Poultry head wrappers come in various sizes. The one most commonly used for hen and small tom turkeys is 7 by 7 by 10 by 14 inches; for large turkeys, 9 by 9 by 12¾ by 18 inches. These wrappers can be bought, cut to order, from almost any paper-supply house or from dealers in poultry and packing-house equipment. They can usually be bought even in small quantities and of good quality, at about 10 cents a hundred. Head wrappers of the usual size weigh from 5 to 12 pounds a thousand, depending on quality and finish. (Table 3.)

TABLE 3.—*Weight of parchment head wrappers*

Weight and finish of stock	Weight per 1,000 wrappers	
	Small size, 7 by 7 by 10 by 14 inches	Large size, 9 by 9 by 12¾ by 18 inches
	Pounds	*Pounds*
30-pound:		
Unwaxed	5.10	8.44
Waxed	5.78	9.57
35-pound:		
Unwaxed	5.95	9.84
Waxed	6.64	10.97
40-pound:		
Unwaxed	6.80	11.25
Waxed	7.48	12.38

Generally it does not pay a producer or packer to make head wrappers if those of good quality can be bought. A packer should use a uniform wrapper for all his turkeys, and all members of a turkey pool should use uniform wrappers—of the same quality, color, and finish. This makes a package more attractive and is usually well worth the small cost. By pooling their orders for wrappers, a group of independent producers or members of turkey pools can assure themselves of uniformity and usually can get a reduction in price.

With a little care, producers can soon learn to wrap the heads correctly. Too often the appearance of a nicely dressed lot of turkeys is spoiled because the carcasses are smeared with dirt and blood through carelessness or through inadequate head wrapping.

If it is possible to arrange the turkeys in the cooling room so that the blood from those on the top row will not drip on those underneath, it is better not to wrap the heads until the animal heat has been properly reduced and the blood has stopped dripping. If there is not enough space in the cooling room for such an arrangement, the heads should be wrapped before the turkeys go into that room.

An experienced operator can wrap several heads per minute. In wrapping the head allow the turkey to hang on the cooling rack, head down. With the left hand hold the wrapper alongside the back of the neck, long side up, so that the bottom of the wrapper will come at least 3 inches below the beak. A corner of the wrapper is held with the thumb of the left hand, with the edge pointed toward the opposite corner. (Fig. 7, A.) Keep the wrapper stretched tight.

With the right hand grasp the upper right-hand corner of the wrapper and pull the paper forward around the head of the turkey. Wind the paper tightly around the neck as far as it will go, the thumb of the left hand still holding tightly to the upper left-hand corner of the wrapper. (Fig. 7, B.) The wrapper now has the form of a bell or cone, large end at the bottom. (Fig. 7, C.)

With the fingers of the right hand tuck the edge of the wrapper up along the side of the head, tucking from the bottom first. With the thumb tuck the opposite side, or turn the head around and tuck the opposite side with the fingers, as in the first operation. (Fig. 7, D.)

The wrapping operation is now completed and, if it has been properly done, the wrapper fits tightly to the head and the turkey can be handled and boxed without danger of the wrapper coming loose. The wrapper should be drawn so tightly around the neck that the skin protrudes over the edge of the wrapper. (Fig. 7, E.)

HOW TO SEW TORN SKIN

It is well, of course, to dress the turkey so carefully that there will be no need for thread and needle, but when accidental tears do occur it is better to sew them up and protect the flesh underneath than to leave them open and susceptible to bacterial infection.

Knot the thread as in sewing any other material, using a double thread. Insert the needle near the opening of the cut and just above it. Draw the thread through, to within an inch of the knot; then slip

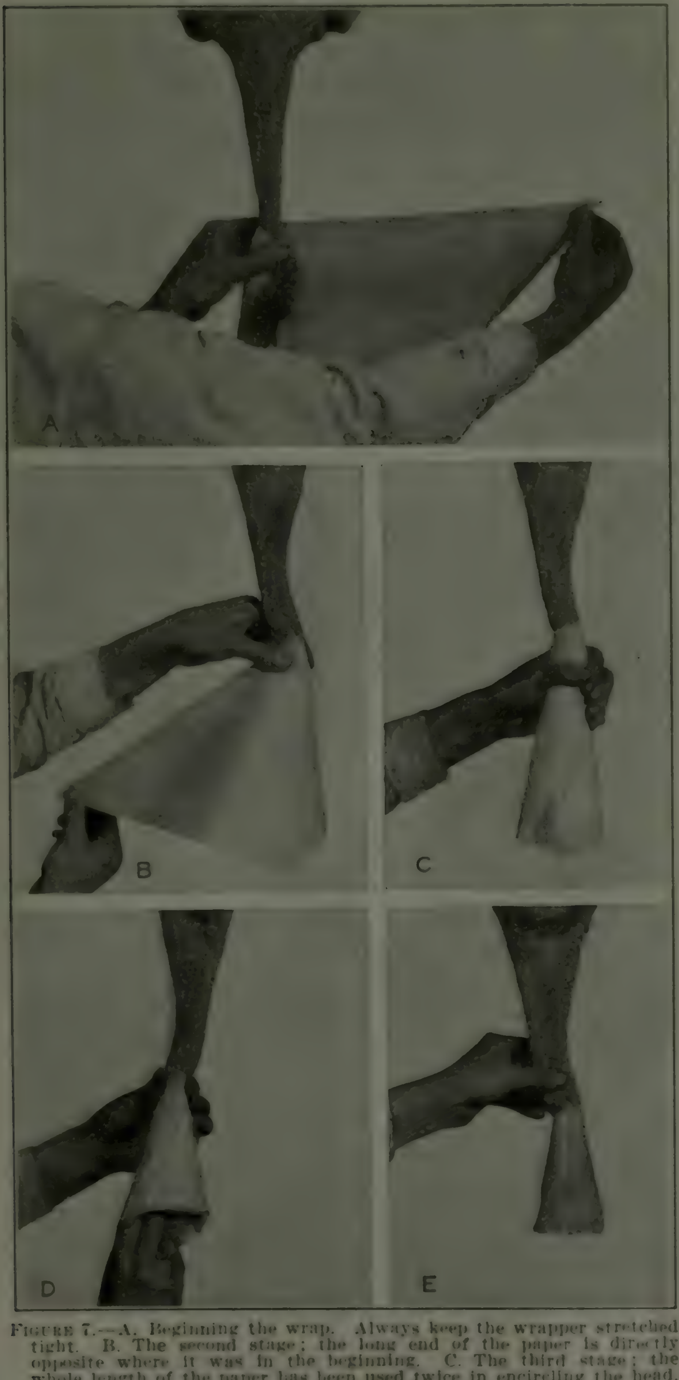


FIGURE 7.—A. Beginning the wrap. Always keep the wrapper stretched tight. B. The second stage; the long end of the paper is directly opposite where it was in the beginning. C. The third stage; the whole length of the paper has been used twice in encircling the head. D. The fourth stage; the paper is tucked tightly between the head and the opposite side of the wrapper. E. The completed head wrapper. If it is properly put on it will be impossible to remove the wrapper without tearing it

the needle back between the threads that were not drawn through, and pull tight. This holds the thread fast and prevents the knot from slipping through the skin. Using an overlap stitch, continue the length of the tear, drawing the two edges of the torn skin snugly together. When the sewing is completed draw the needle between the skin and the loop of the last stitch. Draw tightly and cut the thread about one-half inch from the knot. If properly sewed, the cut will hardly be noticeable. Although it is not desirable to

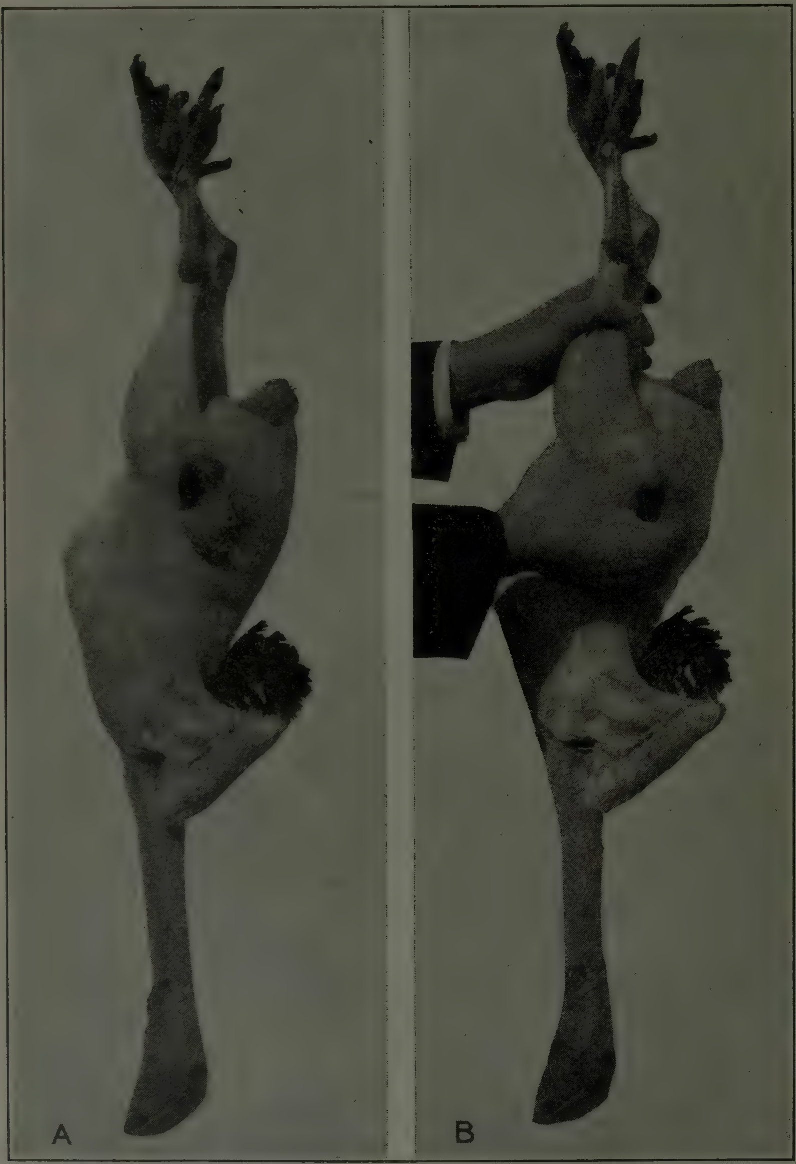


FIGURE 8.—A badly torn skin: (A) Before being sewed and (B) being sewed. The sewing is simple and, with a little practice, can be done quickly

have this thread in the skin of the turkey, the protection to the meat more than offsets the disadvantages of sewing and well justifies the effort. (Fig. 8.)

HOW TO REMOVE CROPS

It is of primary importance that all turkey crops be free of feed, not only because of unfair trade practice in selling worthless material but because of the great danger of spoilage caused by the feed. Fermentation sets in very soon after the turkey is killed, especially if the crop contents are bran and other soft-grain feeds. The contents quickly sour and form gas, give off an offensive odor, and cause the skin over the crop to turn dark. Unless the turkey is drawn immediately, the flesh around the crop is likely to become contaminated and the meat of the turkey to have a sourish taste. If it is necessary to kill turkeys that have full crops, the crops should be removed immediately, while the birds are still warm, and the incisions should be sewed up.

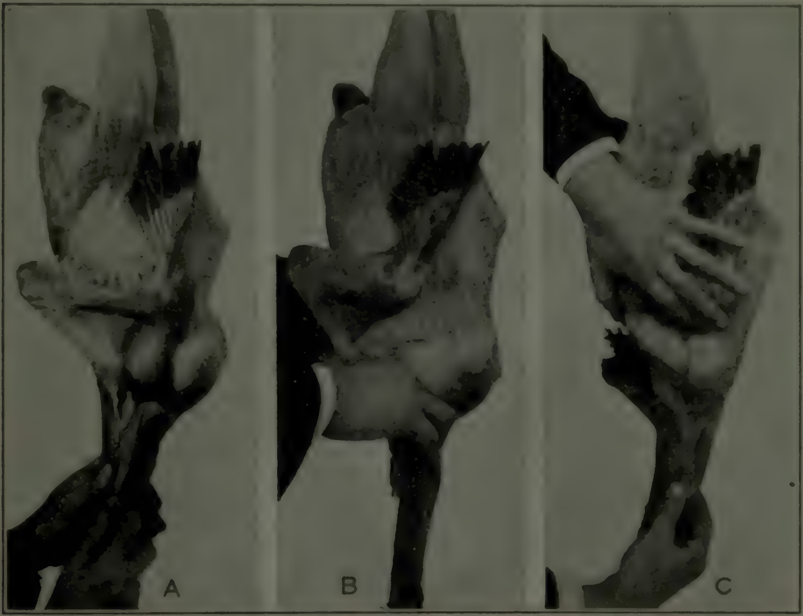


FIGURE 9.—A. The skin of the neck as cut to remove the crop; B, the crop will come out readily if removed while still warm; C, the same turkey shown in A and B. The crop has been removed and the incision sewed; thus the meat is protected from drying out and from dirt and contamination

Some packers remove the feed by puncturing the crop with a knife and then squeezing out the feed. Such a practice is to be severely condemned, for it is impossible to remove all the feed by it, and the remaining feed turns sour and runs out, thus soiling the turkeys when they are hung by the feet. The skin dries out over the region of the crop, and this gives the turkey an unsightly appearance.

To remove the crop properly, the skin should be cut along the neck behind the wing of the bird so that the incision will not show from the front. The cut should be from 2 to 3 inches long, depending upon the size of the crop. (Fig. 9, A.) Care should be taken not to cut into the crop. Then the first two fingers are run through the opening to loosen the connective tissue around the crop. (Fig. 9, B.) The fingers should completely encircle the crop to prevent it from tearing, and the entire crop can be removed with a slow pull. The gullet should be pulled out and cut off as far away from the crop as possible. Any dirt or blood left around the opening should be carefully sponged off.

The incision is next sewed up by the same procedure as in sewing torn skin. (Fig. 9, C.)

PRECOOLING

It is very necessary that all the animal heat be removed from the turkeys before they are packed. If this is not done severe losses from spoilage will occur. Producers who must depend on the weather for cooling the birds may have difficulty when the temperature is above the freezing point. Every packer of turkeys should have a thermometer with which to determine the temperature before packing.

After the turkeys are cleaned they should be hung by their feet, so that any blood remaining in the mouths will drip out. This is perhaps the most satisfactory position for cooling, although hanging a bird while it is still warm has a tendency to stretch the frame and give it a somewhat poorly fleshed appearance. To avoid this, some packers, especially if they expect to pack the turkeys in barrels, lay the birds on racks, breast up, and allow the heads to hang down over the sides of the racks. Suitable racks can be made of 1-inch boards, 8 feet long and 14 inches wide, supported on legs that are 2 by 14 inches and 10 inches high. The racks can be placed one on top of the other to any desired height. If refrigerator cars are used for precooling, racks of this size will just fit crosswise of the car. The disadvantage in the rack method of cooling is that the turkeys do not cool so quickly as when hanging, and there is more likelihood of skin discoloration at the points where the turkey rests on the rack.

The turkeys should be cooled indoors. They should never be allowed to hang in the wind, as this dries out the skin and causes undue shrinkage.

Where mechanical refrigeration is available, the room temperature should be near the freezing point. At least 24 hours of such temperature is needed to reduce the body temperature sufficiently before packing; in some cases as much as 36 hours is required. The internal temperature of the turkeys should be at least 34° F. to avoid all danger of spoilage. The temperature is determined by inserting the thermometer through the vent and up the intestines to about the center of the carcass, leaving it there a few minutes before it is withdrawn so that the mercury will register. The temperature of the largest turkeys and those nearest the door or on the top rows should be taken. If these turkeys have been sufficiently cooled, it is safe to assume that the temperature of the others is low enough to permit packing.

The use of refrigerator cars as precooling rooms has proved satisfactory where other mechanical refrigeration is not available. The cars are usually iced to full capacity, and 10 per cent by weight of salt is added to reduce the temperature still further. The car should be iced for at least 12 hours before the turkeys are put in. In most cases the temperature of the car by this time will be below freezing, but the heat of the turkeys warms the air so much that there is little danger that the carcasses will freeze too rapidly.

The turkeys may be placed on racks in the car or hung by their feet in much the same way as in the refrigerator room. Two-by-four supports are usually fastened crosswise in the car, and the turkeys are suspended from them. (Fig. 10.) The lower row should be hung first, high enough to bring the heads just a few inches above the floor rack. The second row is then hung so that the heads will come slightly below the feet of the turkeys underneath. Three rows usually fill the space between the floor racks and the roof.

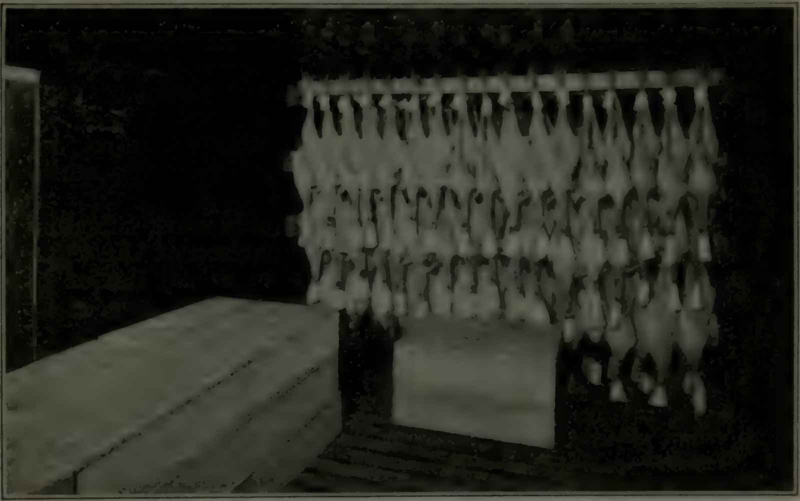


FIGURE 10.—Interior of a refrigerator car used for precooling. When the load is well braced the turkeys may be shipped to near-by markets without being boxed

Carcasses properly hung and braced can be shipped a considerable distance without damage, and the shipper may be able to send such carcasses to be packed at a packing plant that has cooler space.

If the turkeys are boxed before they are shipped, the boxing should be done inside the car; if there is not enough room in one car a second car should be used. Under no conditions should the turkeys be taken from a precooling car and then packed in warm air.

SAVING THE FEATHERS

In communities in which the live turkeys are brought to a central dressing plant or in which packers dress a considerable number of turkeys each season there is often an opportunity to sell the feathers. White feathers are always in best demand and bring the highest prices.

Individual producers who pick their own turkeys with a little extra care can sometimes market the feathers at a small profit. The great difficulty for individual producers is to obtain enough volume to ship by freight, as the extra cost of express shipments will usually absorb the profit if the distance to market is great.

The different kinds of feathers—body, wing, and tail feathers—must be kept separate and must be thoroughly dried before being shipped, or they are likely to mold and mat together, and thus be unsalable. Before being bagged the feathers should be placed loose in a dry room and turned or " forked " every two or three days until all moisture disappears.

The tail feathers should be packed separate from the rest, and only the long ones used. The short tail feathers are of small value and, if shipped at all, should be packed by themselves. The large quill feathers on the two joints of the wing next to the body usually bring a good price; they should be separated from the tail quills. As the quills growing on the tip of the wing are fleeced on only one side, they are seldom worth saving.

The body feathers are packed in burlap bags. They are pressed tightly together and the tops of the bags are securely tied or, better, are sewed with darning needle and ordinary cord string. The quills should be packed in lightweight boxes or in burlap bags. They should be laid straight in the package, all quills pointing in one direction. If stuffed indiscriminately into the bags the quills are broken and their value reduced if not lost.

The price of feathers is subject to considerable market fluctuation. The following tabulation is given as a comparison of the values of different types of feathers rather than as an actual list of prices one may expect. Price quotations, delivered at St. Louis, of different kinds of turkey feathers in February, 1932, were:

Class of feathers	Cents per pound
Body, all white, full fleeced, dry picked	35
Body, colored, full fleeced, dry picked	4
Tail, all colors, straight and clean, no shorts	25
Wing, all colors	8
Pointers	1
Tail, wing, pointers, and shorts, mixed	7

It is well for a producer or packer to consult feather buyers before going to the labor and expense of saving and shipping the feathers, and to use his own judgment as to whether the work is likely to be profitable under the circumstances.

HAULING TO MARKET

If a producer dresses his own turkeys, he should get them to the dealer or packing station just as soon as they are sufficiently cooled. If the weather prevents precooling on the farm, the carcasses should at least cool overnight and then be delivered to the station early in the morning, while the atmospheric temperature is still low. Turkeys should not be hauled immediately after being picked, as the warm skin is very tender and is easily scuffed or broken.

It is better to pack the turkeys loosely in a wagon or truck, rather than to put them in barrels or boxes and then rehandle them at the packing plant. A layer of clean, dry straw, about a foot thick, should be placed in the bottom of the truck and a layer of turkeys carefully placed on top, breast up. Additional layers of turkeys can be placed above the bottom layer. If carefully handled and packed, the turkeys can be stacked three or four layers high without much damage. The load should not be packed much higher than this, as too much weight on the lower layer of turkeys will cause considerable damage. A producer can well afford to make an additional trip to the station rather than injure his turkeys and cause them to be reduced in grade. A piece of canvas or some form of covering should be stretched over the top of the load to protect the turkeys from the sun and from dirt.

GRADING

Grading should be done as the turkeys are received from the producer, or if the birds are dressed at the packing plant they should be graded as soon as they are sufficiently precooled. In ordinary commercial channels three grades of edible turkeys are sufficient to meet most requirements. Turkeys should be graded not only as to quality but also as to color and size. A 2-pound variation in weight of turkeys packed together is as much variation as is desirable, and a 3-pound variation is the widest that should be used, except in a shipment of old toms.

Many good lots of turkeys lose much of their sale value through careless grading. Discussion of grading requires so much detail that it can not be given in the space available in this bulletin. For a description of the United States standards and a discussion of grading turkeys according to these standards see the mimeographed statement Tentative United States Standards and Grades for Dressed Turkeys. As long as the supply lasts, copies may be obtained from the United States Department of Agriculture.

WEIGHING AND SHRINKAGE

After the turkeys have been graded into separate lots they are ready to be weighed. The empty box to be used for packing, containing the paper linings and box cover, should be weighed first and this total tare weight, as it is called, should be marked or stenciled on the box. After the turkeys are packed and the cover is nailed the box should again be weighed and the gross, tare, and net weights stenciled on the box.

The scales should be carefully tested each day to see that they are properly balanced, and the empty box and the packed box should be weighed on the same scales. Careful weighing of the turkeys is very important; if weighing is improperly done, disputes and errors are likely. There is sure to be some natural shrinkage through absorption of moisture from the carcasses by the atmosphere and the wooden container. If the weights are too high in the beginning, they will show up as badly in error by the time the shipment reaches market. If the tare weight at time of shipping is a unit and a fraction of a pound, the next higher unit should be marked as tare. For example, if the tare is 17½ pounds, it should be marked as 18 pounds. On the other hand, if the net weight is a unit and a fraction, the fraction should be disregarded and only the unit stenciled on the box; for example, if the net weight is 187½ pounds, the box should be marked 187 pounds, net.

In commercial practice the tendency is to accept a slight shrinkage, say, about one-half of 1 per cent, or a 1-pound shrinkage on a 200-pound box of turkeys. Careful weighing and stenciling at the packing plant is necessary in order to keep within this small margin.

BOXES AND BARRELS

Boxes are recommended for packing, in preference to barrels. The possible exception is in the packing of heavy old toms. The turkeys carry to market in better condition when packed in boxes, as the "sweating" induced by close contact in barrel packing is likely to discolor the skin, especially if the barrels are permitted to stand for some time after the turkeys are packed, or if the temperature is not kept near the freezing point continuously. In box packing the air has freer circulation around the turkey, so that they usually reach market with drier skin. Moreover, it is much easier for the cold air of refrigeration to penetrate the boxes than the barrels.

Two types of boxes are in use—the single-layer box and the double-layer. There are so many advantages in the use of the single-layer boxes that they are rapidly replacing the double-layer type in most markets. The main advantage is that carcasses in single-layer boxes can be chilled more quickly and less spoilage is likely to occur. Then there is less skin discoloration if turkeys are packed singly than if one bird rests on another. The single-layer box permits easier inspection, as the entire contents can be examined on the removal of the cover.

There are, however, some minor advantages in barrel packing. In most parts of the country barrels can be obtained more cheaply than boxes, capacity considered. They are more easily handled and can be packed more quickly, saving both time and labor. But the principal consideration is the condition of the product when it reaches the market. The advantages of the box container in this respect more than offset those of the barrel, particularly if a fine pack of turkeys is to be put up. If barrels are used, they should be new and free from any odors that might be absorbed by the turkeys.

The most suitable box material depends to some extent upon local conditions. If certain suitable kinds of timber are grown near by, a packer will usually find it to his advantage to buy boxes locally, for he can get them on short notice and save transportation charges. Any strong lightweight wood, free of odors, will answer the purpose. Cottonwood, spruce, or white fir are most commonly used. Ordinary pine lumber is not desirable, as turkey meat packed in pine may acquire from it a disagreeable flavor.

It is convenient and economical to use only two or three sizes of boxes, suiting the number of birds to the size of the box. In this way, for example, a box of the same size can be used for packing 8 heavy young toms, 10 medium-sized, or 12 small ones. Each turkey may be packed on its side, slanted, or breast up. The breast-up method is coming more and more into favor and has proved very satisfactory. In Table 4 are given four box sizes that have been successfully adopted by some packers. There are many advantages in these sizes, but the boxes are so large that handling them is difficult and the strain from the heavy weight they contain is likely to cause them to bulge or break.

TABLE 4.—*Dimensions of boxes for packing turkeys, single layer, breast up, and side pack*

BOXES FOR 10 TO 12 TURKEYS

Weight of birds (pounds)	Inside measurements			Thickness of lumber	
	Length	Width	Depth	Ends	Top, bottom, and sides
	Inches	*Inches*	*Inches*	*Inch*	*Inch*
Under 9	30	18	7	7/8	1/2
9-12	30	19	7 1/2	7/8	1/2
12-15	32	20	8	7/8	1/2
15 and over	32	21	8 1/2	7/8	1/2

BOXES FOR 6 TO 8 TURKEYS

Weight of birds (pounds)	Length	Width	Depth	Ends	Top, bottom, and sides
Under 9	25	18	6 1/2	3/4	7/16
9-12	26	19	7	3/4	7/16
12-15	27	20	7 1/2	7/8	1/2
15 and over	28	21	8	7/8	1/2

Both hens and toms may be packed in boxes of these sizes, the hens and small toms being packed breast up and the heavy toms being either slanted or side packed.

A box smaller than any of these is increasingly in demand. There are many advantages in having 6 or 8 turkeys packed in the box rather than 12 or 14. With the smaller number, dealers can buy more assortments in sizes without "breaking" the boxes, and the smaller sizes carry better to market and are more easily handled. Table 4 also gives the dimensions for smaller boxes suitable for packing a smaller number of turkeys.

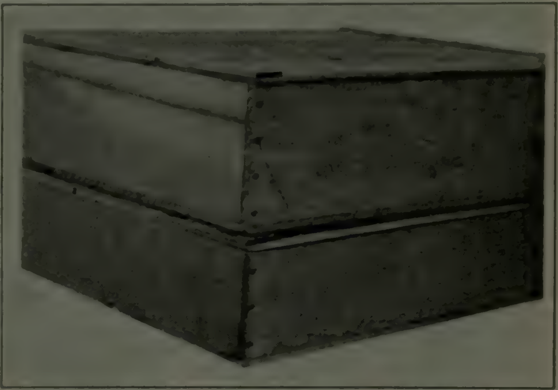


FIGURE 11.—Boxes with cleated tops. The advantages of this type of box are well worth the slight additional cost

The depth of the boxes for 6 to 8 turkeys is one-half inch less than that of boxes for 10 to 12 turkeys. This necessitates the packing of some of the larger turkeys slightly on the side, or slanted so that the peak of the breastbone rests on the side of the adjacent turkey. Six or eight hen or tom turkeys can be packed in the smaller boxes or, if the birds are very small, as many as 10 can be packed in a box.

Cleated box covers should be used on all boxes, regardless of type or size. (Fig. 11.) Uncleated box covers are easily split; it is almost impossible to remove them without breaking; and after the boxes are once opened for inspection, the covers are so damaged that the appearance of the whole box is spoiled. Cleats hold the boards of the lid together and facilitate more rapid refrigeration by making an air space between the boxes.

BOX AND BARREL LININGS

A good-quality 30-pound parchment or waxed parchment paper should be used in lining the boxes or barrels. Usually the waxed paper is more nearly blood proof than the parchment, and gives better protection from blood stains. The parchment liner, however, is less easily torn and more easily handled. All things considered, a high-grade parchment, waxed on one side, is preferred to other types. The parchment is strong and easily handled and the waxing renders it practically moisture proof and protects the skin of the turkeys from drying out.

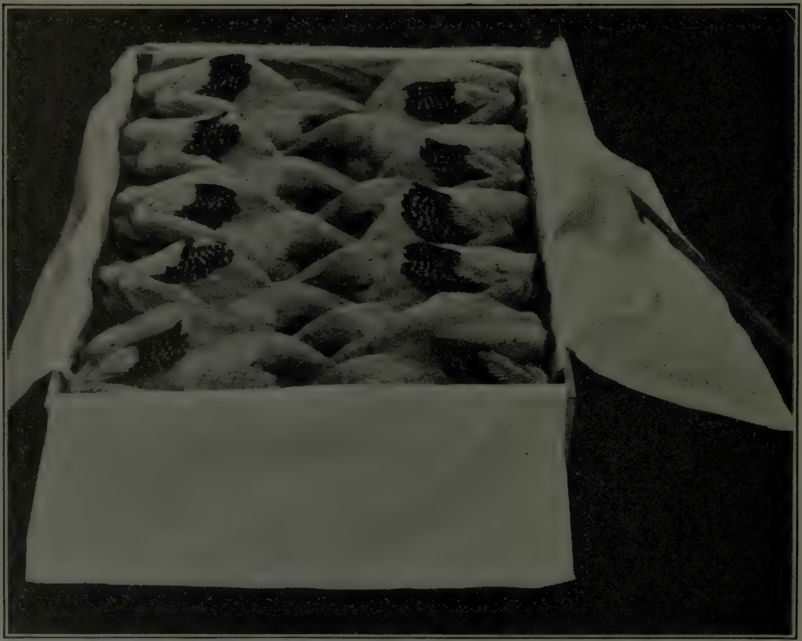


FIGURE 12.—A box of turkeys packed breast up. Each side liner should be long enough to reach the opposite side of the box

At least two strips of paper should be used in lining the boxes, both of them cut to fit the size of box. The first strip should be placed crosswise of the box and the second lengthwise, so that they cross each other at the bottom. The strips should be sufficiently long to allow them to overlap each other at the top of the box when it is filled. (Fig. 12.) This will give a double thickness of paper around both the top and the bottom, where the turkeys are most susceptible to damage from box rubbing. Somewhat less than one-half pound of paper will be required for each box.

Box liners can be bought already cut, any given size, or can be bought in rolls and torn off at any length desired. If the rolls are used, they should be placed in a regular paper rack fitted with a blade for tearing a straight edge. The required length for each liner should be marked on the counter on which the rack rests, so that strips of a uniform length can be torn off without measuring each time.

BOX PACKING

No matter how good the quality of the turkeys or how carefully they are dressed and graded, much of the sale value is lost if they are not well packed. An attractive package means a great deal in making sales, and considerable money is lost each year by operators who do not take the necessary precautions in packing.

There are three methods of box packing: The side pack, the slant pack, and the breast-up pack. The side pack is not used as much as formerly, and the slant and breast-up packs are coming more and more into favor.

With the side pack, the first turkey placed in the box should be placed with the breast toward the operator, wing up. The second turkey should be placed with the back toward the operator, and against the end of the box, and the butts of the two turkeys should be interlocking. The feet and heads should be bent underneath the birds, so they will not show when the box is opened. (Fig. 13.) The packing is then continued, the turkeys being alternated from one side to the other until the box is filled.

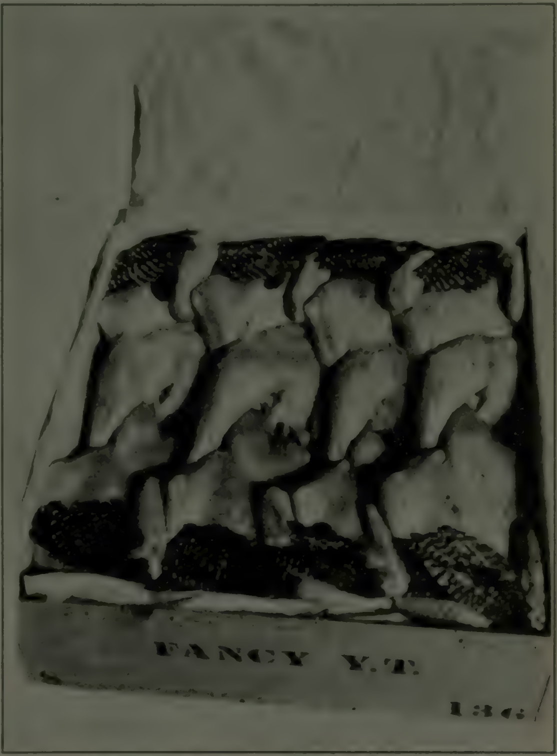


FIGURE 13.—A well-packed box of young tom turkeys. Heads and feet are hidden, and uniform feather coloring adds to the attractiveness of the box

The slant pack is used chiefly in packing tom turkeys. It makes possible the use of the same sized box as is used in packing the hens. In starting the pack both of the turkeys in the end of the box are packed with the backs toward the operator. The other turkeys are also packed with backs toward the packer and are all slanted so that the breastbones of the first two turkeys will lie against the sides of the adjacent turkeys. The turkeys will then rest neither on the side nor back, but mostly on the hip and wing. The heads should be tucked under so as not to show, and the feet should rest under the opposite bird. The breasts of the last two turkeys should lean against the end of the box and should fit very tightly so that all space is taken up. The entire contents should be packed so snug that the turkeys can not shift around as the box is handled.

With the breast-up pack the end of the box farthest from the operator should be elevated at least 12 inches higher than the nearest end, to keep the turkeys in place as they are being packed. The first turkey is placed breast up in the lower end of the box. The head should be bent down, a little to one side, and tucked under the back. One leg of each turkey may be placed between the legs of the opposite carcass in order to hold the birds more upright in the box, or, if care is taken, both legs may be extended along the side of the opposite turkey and the same results obtained. The packing continues first on one side, then on the other, until the box is filled. The last two turkeys should fit very tightly in the box to prevent shifting.

In either style of packing the paper lining is next folded over the top and the lid put on for nailing. If only one size of box is used the hens may be packed crosswise of the box and the toms lengthwise. Under either method the main point is to see that all turkeys fit tightly in the container and are fully protected by the paper lining.

NAILING AND STRAPPING BOXES

The boxes should be securely nailed. Sixpenny cement-coated nails are used in nailing the bottoms of the boxes, using at least two nails at each end of the narrow boards and three nails at each end of the wide boards. Four such nails should be used at each end of the sides. In nailing the tops of the boxes smaller nails and fewer of them should be used. Fivepenny wire nails are the most desirable; and unless the top boards are very wide two nails at each end of each board will be enough. If a cleated top is used, four nails at each end of the box will be enough to hold the cover in place, and it will be easier to remove the cover for inspection than if more nails are used.

The 32-inch box should be wired or strapped at each end if shipment is to be made to a distant market. No strapping is necessary on smaller boxes. Medium-sized boxes should be wired with only one wire, directly around the center of the box.

Wire is ordinarily desirable, except when turkeys are packed for export or for some special contract. Metal straps are then used, but they are difficult to remove unless a crimp seal is used; and most merchants object to this or any other device that delays their operations during the busy season. Thirteen-gage galvanized round wire, having a tensile strength of not less than 300 pounds, should be used in wiring. The wire or straps should be drawn tightly around the box, preferably with machines especially constructed for the purpose. Wires of any desired length can be bought from almost any hardware store.

When metal straps are used, they should be not less than three-eighths inch turned edge, or one-half inch flat metal, 0.015 inch in thickness. Unless the straps are crimped tight, they should be nailed at the edge of the box so that the nails fastening them will penetrate the cover boards and the box ends. As the wires require no nailing, it is best to place them about 4 inches from each end; this gives added support to the center of the box.

If the boards of the cover are not wide enough to cover the box completely, the outside boards should be flush with the box sides and any opening between the boards should be near the center.

BARREL PACKING

Barrels should always be new. The side of the barrel should be lined with parchment paper cut long enough to fold over the top when the barrel is packed. Either parchment or waxed paper is suitable and should be bought in rolls wide enough so that three strips will completely line the barrel and when folded over will give three thicknesses of paper across the top. Between each two layers of turkeys and at the bottom of the barrel a paper circular lining cut to fit the barrel should be placed.

The "squat" and the side pack are both used. The squat pack is usually preferred.

When squat packing in barrels is to be employed the turkeys are cooled on racks, the heads being pulled down tightly between the legs of the birds while they are still warm, and the legs folded up along the breasts. If cooled in this position, the turkeys retain this shape, which makes packing easy. After cooling, the turkeys are placed on their butts in the barrel with backs against the side of the barrel. They are packed as tightly as possible. When small birds are packed in this way an opening remains in the center of the barrel; this opening may be filled with turkeys, placed breast down. A sheet of paper is placed over each layer of turkeys, and the operation is continued until the barrel is filled, the top layer of turkeys protruding an inch or two above the top of the barrel. The barrel should then be rocked back and forth until the turkeys are level with the top or slightly below it. Under no condition should the turkeys extend above the top after they have settled from the rocking. The three thicknesses of paper lining are then folded over the top, a burlap cover is put on, and a hoop is securely nailed over the burlap. The burlap covering should be cut off about 6 inches below the bottom of the hoop. Barrels are sometimes placed on top of each other, and if the burlap comes only flush with the hoop, the weight of the top barrel is likely to pull the burlap loose, thus exposing the turkeys.

When the side pack is used the bottom layer of turkeys is packed on the sides with backs against the barrel and the heads and feet drawn in toward the center. The heads of the next layer are folded under the bottom wings; the necks are packed tight against the butts so they rest on the legs of the preceding turkey. Under this method neither the heads nor the feet of any of the turkeys will show when the barrel is filled.

MARKING THE PACKAGES

Boxes and barrels should be plainly stenciled with the gross, tare, and net weights, number of birds, sex, age, and grade. Private brands or trade-marks usually are put on the packages by the packer.

The stenciled figures should be at least 1 inch high on boxes and 2 inches on barrels. The gross, tare, and net weights are usually shown on the lower right-hand corner of the box, and the number of turkeys, grade, age, and sex on the lower left-hand corner.

STATION (OR LOT)
NO. ____________

PRIVATE BRAND

187
17
170

10 U. S. PRIME Y. T.

When barrels are used, the trade-mark or private brand is usually stenciled on the burlap and the weight is stenciled on the side. If the Government grades are used, the grade name should be stenciled on the side and never on the burlap covering alone.

To prevent smudging from rubbing, all stenciling should be done between the two top hoops rather than on the bilge of the barrel. A quick-drying black ink gives the best results.

SHARP FREEZING

If the turkeys are to be shipped to a distant market they should not be held in the cooler longer than three or four days before shipping. If necessary to hold them longer in order to complete a full car, the carcasses, as soon as boxed, should be put in a sharp freezer (in which a temperature of at least 0° F. or preferably −5° is maintained) and allowed to stand for 24 hours. This gives them a hard chilling and, if shipped at once, they will carry to market with practically no danger of spoilage. They should never be put into the sharp freezer until all animal heat has been thoroughly removed from the carcasses and, once in the freezer, should remain there until shipped.

Handling boxes of turkeys requires special care. The boxes should never be stood on end, and they should be handled with as little jar as possible. Even though carefully packed, the birds are easily dislodged in the box before they are hard chilled, and if packed on end, they have a tendency to settle down and leave a vacant space at the top of the box. The practice of placing the boxes upside down in the freezing room to flatten the breasts is of doubtful value and necessitates considerable handling.

In packing the boxes in the coolor or freezer rooms they should be stripped with slats at least five-eighths inch thick between the layers of boxes to allow the cold air easy access to each box. If slats are not available, the boxes should be so spaced that each successive row will rest on the edges of the row underneath. This will leave an open space between rows nearly the width of the box.

SHIPPING INVOICES

A shipper should make a complete itemized invoice to cover the contents of each car shipped. The invoice should contain the following information: Place and date of shipment, name and address of the receiver, car initials and number, car routing, car-seal numbers, and a list of the contents of the car showing the number of packages of each weight, class, and grade. A copy of this invoice should be mailed immediately to the receiver, so that he can offer the car for sale before it arrives. When grading is done by a licensed Government grader, all these items, together with other detailed information, will be given on the grading certificate issued on each car lot graded. It is well to forward a copy of this certificate to the receiver.

CAR LOADING

The refrigerator car should be iced 24 hours before loading, in warm weather, and 12 hours before, in cold weather. The temperature of the car should be reduced at least to freezing. When the movement to market will require three to four days crushed ice should be used, with 10 to 15 per cent of salt added, depending upon weather conditions. Under ideal conditions each 1 per cent of salt added will lower the temperature of the car 1° F. below the temperature obtained when ice alone is used.

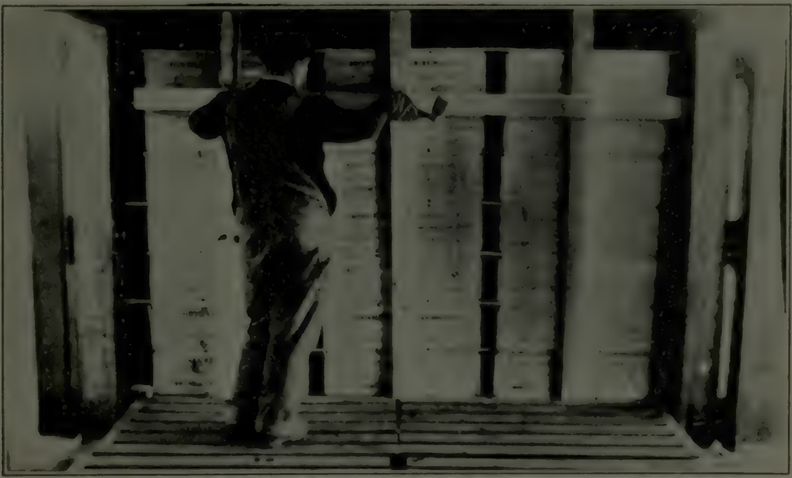


FIGURE 14.—Beginning the center bracing in a refrigerator car. Two by four inch pieces are placed vertically, one near the center of each stack of boxes. Each side is braced in the same way, and the bracings are held tight with 2 by 4 inch crosspieces set between the uprights. Note the slats between each two layers of boxes, and the vertical and horizontal bracing, which permits air circulation and rapid cooling

The car should be examined before loading to make sure that the drainpipes are open, the ice bunkers are in good condition and sufficiently filled, enough floor racks are available, the car is well cleaned, and the doors fit tightly.

Always place barrels and boxes on the floor racks, which are usually part of the refrigerator-car equipment; never place them on the floor of the car. When loading the car, begin in the ends and load toward the doors in the center.

Boxes should be packed lengthwise of the car, their ends tight against each other but the rows 2 or 3 inches apart. Strips of wood one-quarter or one-half inch thick should be placed between the boxes crosswise of the car to allow air circulation throughout the car and to hold the boxes in place. (Fig. 14.) Ordinary building lath makes good stripping, or strips may be ordered cut to the width of the car. The strips should be held in place with fourpenny or fivepenny nails, one strip on top of each end of the box. One nail for each box is enough, as side shifting is not so likely as end shifting. The boxes should be packed as tightly as possible.

Any space left in the center of the car should be securely wedged with wooden bracing. The car should not be filled more than three-fourths of the way to the top, as the temperature at the top of the car is always several degrees higher than at the bottom. An ordinary refrigerator car two-thirds full will easily carry between 20,000 and 25,000 pounds.

A FINAL WORD

A good turkey is a valuable food product. At a retail price of 40 cents a pound, a 15-pound turkey costs the customer $6. It is to the interest of the producer, packer, and retailer to see that the customer is satisfied with her purchase, so that she not only will continue to use turkey as the center of the Thanksgiving and Christmas dinners, but will buy one occasionally at other times as well.

Only through extreme care in breeding and rearing and in dressing and marketing can good turkeys be offered on the retail market. The cost, time, and labor involved in careful preparation for market may not seem worth while to the careless producer or dealer, yet it is only by placing a quality product on the market, thereby encouraging consumption, that producers can expect to market the annual turkey crop at a profit that will justify large production.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	ARTHUR M. HYDE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel and Business Administration.	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Solicitor	E. L. MARSHALL.
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Forest Service	R. Y. STUART, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Bureau of Plant Quarantine	LEE A. STRONG, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Weather Bureau	CHARLES F. MARVIN, *Chief.*

U. S. GOVERNMENT PRINTING OFFICE: 1932

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

U. S. DEPARTMENT OF
AGRICULTURE
FARMERS' BULLETIN No. 1695

PREPARING APPLES FOR MARKET *in* BARRELS *and* BASKETS

GRADING AND ATTRACTIVENESS of the pack are important factors in determining the prices growers receive for their apples. The barrel is used as a container for apples in the eastern and central parts of the United States. The bushel basket is used in these regions and is also used extensively in Colorado, Idaho, and Utah. Use of the bushel basket, particularly the straight-sided type, has increased. Machines of various types are largely used for sizing the apples, which are graded by hand as they move on canvas or roller conveyors toward the sizing device.

Official standards for apples packed in barrels and baskets have been issued by the United States Department of Agriculture, and Federal-State inspection service is available in important commercial producing districts. Federal inspection service is available at important markets. Standards and inspection services are widely used.

Barrels and baskets should be well faced and well filled to insure a tight pack. Barrels must be properly headed to avoid unnecessary bruising of the contents. Various devices are used in packing the baskets. Shredded oiled paper should be distributed among the apples intended for storage, as they are packed, to prevent or reduce damage from scald. Containers should be plainly marked with descriptions of their contents.

Packing houses should be conveniently and properly located, with adequate lighting facilities, and so arranged that fruit passes directly through them from receiving platform to loading space.

Both loose and packed fruit must be handled with great care to avoid bruising. If not to be marketed immediately, packed fruit should be placed in cold storage promptly. Car-lot shipments should be so loaded as to prevent damage through shifting of packages in transit.

This bulletin is a revision of, and supersedes, Farmers' Bulletin 1080, Preparation of Barreled Apples for Market.

Washington, D. C. Issued January, 1933.

PREPARING APPLES FOR MARKET IN BARRELS AND BASKETS[1]

By R. R. Pailthorp, *Senior Marketing Specialist*, and J. W. Park, *Agricultural Economist, Division of Fruits and Vegetables, Bureau of Agricultural Economics*

CONTENTS

	Page
Changing conditions	1
Harvesting	1
Time of picking	2
Number of pickings	2
Method of picking	3
Picking utensils	3
Ladders	5
Basis on which pickers are paid	5
Handling fruit from tree to packing table	5
Grading and packing	6
Grading tables	7
Sizing and sizing machines	9
Additional equipment for sizing machines	12
Removing spray residue	14
Power	14
Grading and packing—Continued.	
Conveyors	14
Packing the barrel	14
Packing the bushel basket	18
Marking the containers	22
Packing houses	22
Location	24
Lighting	25
Storage accommodations	26
Ventilation	26
Suggested floor plans	26
Hauling	32
Loading in cars	32
Cold storage	33
Grading laws and inspection	34

CHANGING CONDITIONS

A MOVEMENT TOWARD concentrating the apple industry in the more favorable locations and eliminating many farm orchards has been taking place since 1912. This has been particularly true in some parts of the barrel-and-basket apple region, and should facilitate the use of better methods and equipment in preparing apples for market.

In the eastern and central parts of the United States apples are usually packed in barrels or bushel baskets. In Colorado, Idaho, and Utah, the barrel is not used, but the basket is used extensively. This territory comprises the barrel-and-basket region and during the period 1927 to 1931 it annually produced more than half of the commercial apple crop of the United States. The average for the 5-year period was 61 per cent. Since 1922 an increasing proportion of apples have been packed in bushel baskets.

The competition from a large tonnage of carefully graded boxed apples has resulted in a more exacting market and has emphasized the importance of the closest study of the details of operation and equipment in marketing apples packed in barrels and bushel baskets. Well-chosen equipment, up-to-date methods, and careful supervision of crews are necessary to insure a well-graded and attractive product, and lowered costs are necessary to meet competition.

HARVESTING

Much fruit reaching the markets each season is greatly impaired in quality by being picked at the wrong stage of maturity—either too early or too late for best results. This mistake may be made because of failure to understand when the fruit should be picked, failure to interpret correctly under field conditions the factors that indicate the proper stage of maturity, or because such factors as available labor and weather conditions make it difficult to pick the fruit at the proper stage.

---

[1] This bulletin is based in large part upon Farmers' Bulletin No. 1080, Preparation of Barreled Apples for Market, by W. M. Scott, H. C. Hetzel, H. W. Samson, and M. Stockton, formerly of the Bureau of Agricultural Economics.

TIME OF PICKING

Varietal characteristics, seasonal variations, cultural practices, and other factors affect the maturity of apples. The three of greatest importance in determining when to pick the fruit are: (1) The degree of yellowing in the unblushed or uncolored portion of the fruit; (2) the firmness of the flesh of the fruit, which can be accurately measured by pressure-test apparatus; and (3) the way the fruit is holding to the tree or the ease with which it may be picked. For the details of these maturity tests and for statements of the proper time to pick a number of important commercial varieties, growers should consult Department Bulletin 1448 of the United States Department of Agriculture.

Certain other indications of ripeness, such as degree of red color and color of the seeds, have been used to some extent. Most normally colored fruit of red or striped varieties is ready to harvest if it has attained the proper size and if it separates readily from the spurs. For yellow, green, and russet varieties the size of the fruit together with ease of separating the stems from the spurs is frequently used as a maturity test. Fruit is usually not ready if it clings to the spurs so tightly that the stems are pulled out or the spurs are broken.

Red color is not always a reliable index of maturity, as the degree of color varies with the season, the size of the crop, the vigor and age of the tree, soil conditions, and other factors. Frequently, in an attempt to obtain good color, a crop of pale fruit is allowed to hang so long that it is overripe when harvested. The degree of yellowing in the unblushed portion of the fruit is considered a better criterion of maturity than is the degree of red coloration. Brown color of seeds is not a reliable index of maturity, as colored seeds are often found in immature fruit, but it is certain that the fruit is not ready to pick before the seeds turn brown. No one test is considered entirely reliable as an indicator of the best time for picking.

Fruit harvested when immature is inclined to scald in storage and, in extreme cases, may shrivel. Its quality and flavor may be impaired. On the other hand, if it is allowed to become overripe on the trees it will not keep so long in storage. To get the best results in storage and in the markets, each variety should be considered separately.

Maturity is not so important in the case of summer varieties of apples not intended for storage. The larger apples of summer varieties are sometimes picked for cooking as soon as they are large enough to meet the demands of the market.

NUMBER OF PICKINGS

Most growers remove all the fruit from the trees at one picking, although some make two or more pickings during the season. The advisability of making more than one picking depends upon a number of factors. The extent to which the color and size of the fruit is affected by the load on the trees is one. If trees are heavily loaded it may be advisable to pick the apples on the outside of the trees, especially the larger and better colored specimens, permitting the limbs to lift and expose the poorly colored fruit to the sun. Such thinning also tends to bring about an increase in the size of the fruit that remains on the trees. Other factors that influence the advisability of making one or more pickings are: Amount and cost of available labor, market conditions, average quality of the crop, weather conditions, and length of time before frost is likely to occur.

The second picking is usually made within a week or 10 days after the first. Two pickings are more expensive than one because of the additional time required, though the increase in the market value of the crop may justify them.

METHOD OF PICKING

When picking apples the stems should be separated from the spurs either by giving the fruit a slight rotating motion combined with a sharp upward twist or by exerting a slight pressure with the thumb or forefinger at the joint of the stem and spur, just as the fruit is pulled. The stem should not be torn out, as apples that have been skin-broken in this way are more subject to decay in storage.

If twigs or spurs are pulled off with the fruit they are likely to cause stem punctures during hauling and packing, and since fruit is borne on the same spurs year after year, subsequent crops may be reduced. Some varieties lose their spurs very readily even when the pickers use reasonable care, but growers should insist that these spurs be removed before the fruit is placed in the picking receptacles even if the speed of the work be reduced. Satisfactory results require that the work of each picker be inspected from time to time by the grower or a competent foreman.

PICKING UTENSILS

Drop-bottom buckets, canvas sacks, and round half-bushel baskets are the most common apple-picking receptacles. The use of drop-bottom buckets has increased rapidly. Hamper baskets are used extensively as picking utensils in the apple sections of Delaware and New Jersey.

The rigid sides of the drop-bottom bucket protect the fruit from being bruised when the picker presses the bucket against a ladder or a limb. The canvas drop bottom is in the form of a tube and can be folded or pulled up and fastened so as to close the opening while the bucket is being filled. The canvas protects the apples when they are dropped on the bottom of the bucket, and enables the picker to transfer the contents to a field box or basket without bruising. The rim of the bucket should be well padded and the bucket should be equipped with canvas straps so that it can be attached comfortably to the picker's shoulders, permitting the use of both hands in picking. (Fig. 1.) It is desirable to have the picking bucket somewhat flattened on one side, to fit against the picker's body. In one type of drop-bottom bucket the circumference at the bottom is slightly greater than that at the top. It is claimed that this reduces bruising injury when the bucket is emptied.

Picking sacks differ widely in design and in material. The drop-bottom canvas sacks (fig. 2) holding about one-half bushel are equipped with straps that hold them securely in front of the body as the picker works. The sack is a canvas tube held open at the top by a wire frame. On the bottom of the tube is a snap or rings with which the sack may be closed by folding up the tube and attaching it to a ring or hooks on the front. These sacks, like drop-bottom buckets, are more convenient than baskets because they are so held in place that pickers have free use of both hands. Their chief disadvantage is the greater possibility of bruising the fruit because their sides are flexible.

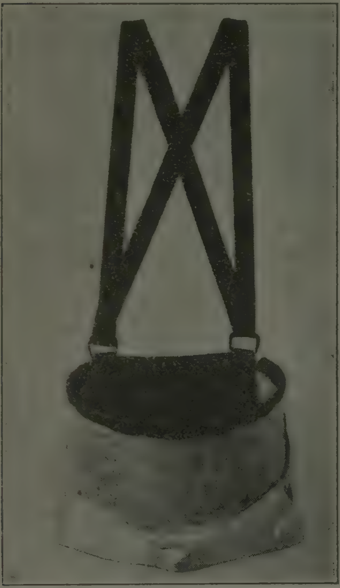


FIGURE 1.—The rigid sides and padded rim of this drop-bottom picking bucket protect the fruit from being bruised

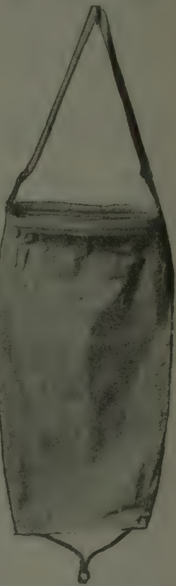


FIGURE 2. — Drop-bottom canvas picking sack. Many growers use homemade burlap sacks holding about three-fourths of a bushel, made easily and quickly from burlap bags with comparatively no expense. Such bags must be inverted to be emptied and this usually causes more apples to be bruised, therefore they are generally recognized as less desirable than the drop-bottom type

Round picking baskets holding approximately one-half bushel, used in all the eastern apple-growing districts, usually are made from staves, and equipped with wire bails or wooden handles. The rigid sides of these baskets protect the fruit from pressure. When harvesting tender varieties such protection is essential. Pickers often place the baskets in a tree crotch or hook them over a limb, and then toss the fruit into them from a distance of several feet, causing severe bruises and often broken skins. It the baskets are padded or lined with corrugated paper the fruit is somewhat protected from such injury. The baskets should be fitted with S-shaped hooks to enable pickers to move them frequently and use both hands when picking from ladders.

The correct method of emptying baskets or sacks should repeatedly be impressed on the pickers. Care should be taken not to drop the fruit. When baskets are emptied into lug boxes they should be lowered to the bottom of the boxes and inverted gently, or the boxes should be tipped so that the fruit rolls from the baskets gently down the side of the boxes. Drop-bottom buckets or sacks can be emptied without bruising the fruit if the bottom of the sacks rest on the bottom of the containers when the sacks are opened.

Each of these utensils is peculiarly adapted to certain uses and one can not be recommended to the exclusion of the others. Successful use of any one kind of picking utensil is largely a matter of management, and two types can often be used to advantage.

LADDERS

Several types of picking ladders are in common use. The ordinary straight ladder, although still used extensively in most sections, is rapidly being displaced by improved types. Its chief disadvantage is its top-heavy tendency, which makes it difficult to set it securely against small branches without breaking them and knocking off fruit. One desirable modification of this ladder has a broad base and tapers toward the top. This construction gives a better distribution of the weight and makes the ladder correspondingly easier to handle.

The pointed ladder is probably most satisfactory, as it is light and can be placed against a limb or fork that would not support a common straight ladder. For picking in the tops of high trees extension ladders are desirable and make it possible to gather fruit which could not be reached in any other way.

Using such ladders is better than allowing pickers to climb the trees. Climbers in heavy shoes are likely to split the crotches and peel the bark. It is generally necessary to climb for part of the fruit borne in the center of the tree; much injury to the tree through such climbing may be prevented if the pickers wear rubber-soled shoes or leather shoes without heels. When picking fruit from the tops of high trees, time may be saved by lowering filled utensils to the ground with a rope.

Stepladders of various kinds are especially satisfactory in harvesting fruit from small trees and from the lower branches of large trees. The most desirable types are wide and flaring at the bottom, narrow at the top, and supported by but one prop. Such ladders can be "set" quickly and securely, if the ground is level, without knocking off the fruit.

BASIS ON WHICH PICKERS ARE PAID

Undoubtedly pickers will work faster if paid on a piecework basis instead of a straight day wage. The piecework basis is advantageous if there is a labor shortage or if low-quality fruit, heavy dropping, or any other circumstance demands quick removal of the crop. Pickers generally make better wages on piecework and any tendency toward carelessness can be avoided by strict supervision. If the grower does not superintend the picking, the damage caused by carelessness may more than offset the advantage of the increased quantity of fruit picked. Work done by each picker can be accurately checked by requiring that a check bearing an identifying number be placed in each basket or box as picked. If the wages are adequate and if the supervision is careful enough, the piecework system can be employed successfully in picking crops of high quality.

HANDLING FRUIT FROM TREE TO PACKING TABLE

If fruit is packed at a central packing house or at a permanent location in the orchard, as is done in many commercial orchards, the fruit is delivered to the packing point in boxes, crates, barrels, or baskets. If the crop is packed on tables that are moved from place to place in the orchard the fruit usually is carried to the tables in baskets or field crates. Crates and boxes are the best containers for moving fruit to the packing shed. as they can be handled conveniently and stacked securely in storage or during hauling, without bruising the fruit.

A durable slatted crate which holds about a bushel is extensively used. (Fig. 3.) The best lug boxes, holding about a bushel, are made of heavy material, with handholes at the ends and cleats across the tops. Providing the pickers at all times with plenty of field crates saves time. In handling and hauling the fruit to the packing shed care to avoid bruising and consequent financial loss is necessary.

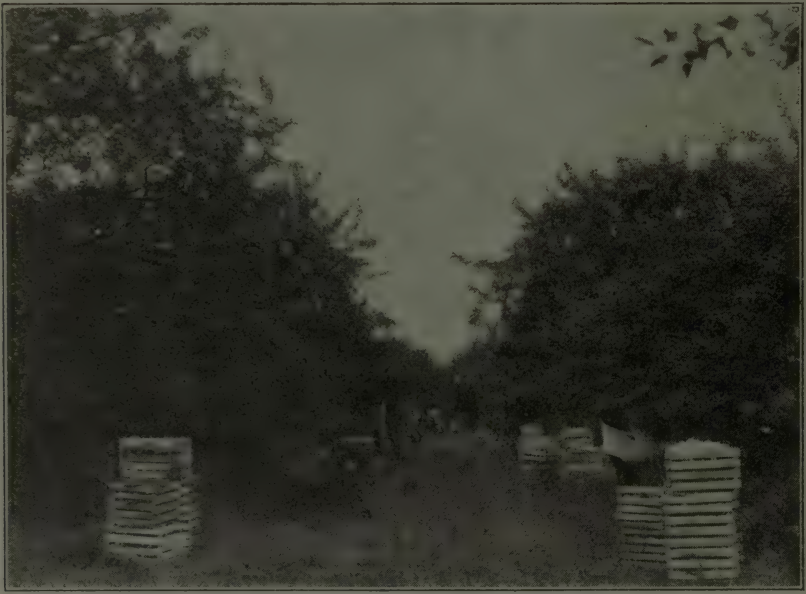


FIGURE 3.—Slatted crates holding about a bushel each are extensively used in hauling apples from orchard to packing house

GRADING AND PACKING

Grading is separating the fruit into classifications according to the degree of freedom from blemishes or defects, and the amount of color in red or striped varieties. The fruit is sized by machinery in most large commercial packing houses. Where it is done by hand, however, grading and sizing constitute one operation. Grading and packing can be most satisfactorily done in packing houses or under shelter.

The principal containers used for the commercial apple crop in the region east of the Rocky Mountains are the barrel and the straight-sided bushel basket. The bushel basket is also largely used in the Rocky Mountain States. Dessert and early varieties are mostly packed in bushel baskets, while the barrel is largely used for export trade and for some storage varieties. The December 1, 1931, cold-storage holdings showed that, of the apples stored in bushel baskets and barrels, 62 per cent were in baskets and 38 per cent in barrels. For December 1, 1930, the corresponding figures were 61 per cent and 39 per cent, whereas for the December 1 holdings of the previous 5 years the figures were 39 per cent in baskets and 61 per cent in barrels.

The United States Department of Agriculture official standards for apples as issued in August, 1931, provide for and define the following grades: United States Fancy, United States No. 1, United States Commercial, United States No. 1 Early, United States Utility, United States Utility Early, Combination, United States Hail, and Unclassified.

It is essential that graders thoroughly know the requirements of the grades being packed, and that the grading be carefully supervised. Care is required at all stages of the grading, sizing, and packing processes to avoid unnecessary bruising of the fruit and consequent price discount.

If the fruit is to be held for some time before being packed it should be properly stored, otherwise it should be packed as soon as possible and removed to storage. In producing sections toward the South the common and most desirable practice is to pack the fruit as soon as it is picked and remove it to storage as quickly as possible.

GRADING TABLES

Apron-type and canvas or burlap grading or sorting tables are used almost exclusively when fruit is graded in orchards and to some extent in packing houses.

APRON TABLE

The apron table or a variation of it is commonly used in all sections. The table shown in Figure 4 is a typical one for packing in the orchard. The bed of this table is slatted so that trash falls through, and inclined so that the fruit as it is graded rolls to the lower end. Here, upon the opening of a stop or trap, it is lowered by means of an apron into the barrel or basket. The end of the table where the packing is done tapers to an opening aproximately 1 foot wide. Fruit to be packed is emptied from field boxes or baskets onto the table or into a large bin from which it is fed to the table through a chute. This method may cause unnecessary bruising.

This type of table is popular because work can be done rapidly on it. It is not altogether satisfactory, as the fruit frequently crowds past the sorters and encourages carelessness. The graders must sort out both defective and undersized fruit and the actual sorting takes place as the fruit is pushed or rolled along to the end of the table, which is frequently kept so full that the apples can not be thoroughly inspected.

Where two grades are packed, it is customary to remove the culls and the second-grade fruit into baskets or barrels and allow the first-grade fruit to run over the table. When one of two grades is sorted out the sorters should always remove that grade constituting the smaller proportion of the fruit, in order to reduce handling to a minimum and to allow the grade constituting the larger part of the fruit to be run over the apron into the barrel. The man who packs the barrel is usually responsible for maintaining the grade. He has charge of the crew at his table, and assists in the sorting by going over the fruit as it passes into the barrel.

CANVAS OR BURLAP TABLE

The second type of grading table is made of canvas or burlap stretched over a 4-cornered frame that is longer than it is wide. Fruit is not run over an apron into the barrel as with the apron table. The apples must be sorted by hand into baskets, in which they are lowered into the barrels. The advantage of this table is that all apples are carefully inspected as they are removed by the sorters. Although as a rule this is slower than handling the fruit over an apron table, the sorters soon become skilled and fast with practice.

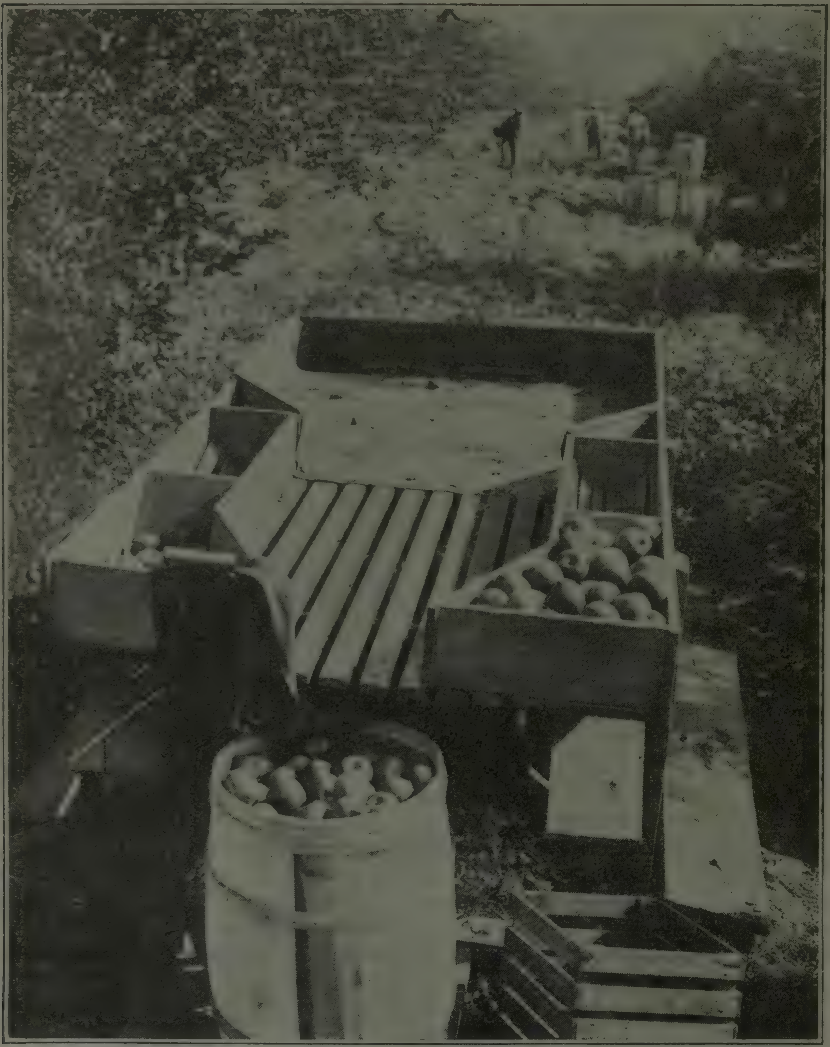


FIGURE 4.—Apron grading table in common use. The apples in the corner pockets have been selected for use in facing

Care is necessary in managing either type of table if the best results are to be obtained. On the apron table the fruit is often bruised by being crowded along with the picking baskets as they are being emptied. Sorters at canvas-topped tables should be cautioned against throwing apples into the baskets into which they are being graded. Such injury may be avoided to a considerable extent by using padded baskets.

SIZING AND SIZING MACHINES

Apples are sized both by machines and by hand. Most machines used in barrel and basket packing size the fruit by measurement, whereas the most popular machine used for sizing boxed apples, sizes by weight.

Various sizing practices according to trade requirements are used throughout the barrel-and-basket sections. One common practice is to separate the fruit into size ranges of 2¼ to 2½ inches in diameter and 2½ inches and larger. The latter range usually includes the greater part of most crops. Some fruit is packed 2¼ inches and larger. Considerable fruit, particularly in baskets, is packed in ¼-inch size ranges, 2¼ to 2½ inches, 2½ to 2¾ inches, and 2¾ to 3 inches, or 2¾ inches and larger. Various other size classifications such as 2¼ to 2¾ inches are used to a limited extent. The sizing can be done more rapidly and accurately by the mechanical sizer than by hand, and the use of the machine enables the grower to give more attention to the grading, since the sorters are not concerned with the size. For sizing in ¼-inch ranges the mechanical sizer is of a value even greater than when apples are divided into only two sizes, since it makes possible a uniformly sized pack with inexperienced help.

The sizing machines used most extensively for barrel and basket packing consist of two principal parts—canvas or roller conveying belts on which the fruit is sorted or graded, and the sizing device proper. The fruit is delivered to the grading belt as it comes from the orchard and is sorted as it moves toward the sizer.

The sizing device of one of the most popular types of machine consists of a series of endless belts composed of rings. (Fig. 5.) The rings in each belt are of a size different from that of the rings in the other belts. Two to four such belts are so arranged that the fruit moves from the one having the smallest rings to that with the largest rings. As the apples are delivered onto these chain belts from the grading belt the smallest drop through the rings of the first and the larger are carried on to the next belt. Where two chain belts are used the fruit too small to be packed drops through the first, which is usually composed of 2¼-inch rings. The rest of the fruit is carried to the second chain, composed of 2½-inch rings, through which all the apples with diameters between 2¼ and 2½ inches drop. The remaining apples, 2½ inches or more in diameter, are carried by a short conveying belt to a packing bin equipped with an apron.

The sizing chains are inclined or otherwise arranged so that the position of the apples is changed several times as they are carried over the rings. In varieties with a long shape this is necessary in order to obtain the measurement of the cross diameter, the dimension used as the basis for all sizing. It is necessary to measure the same diameter of each apple to secure uniformity.

Another popular type of machine is equipped with a series of sizing units, each consisting of an endless, corrugated roller belt having round openings between the rollers. The sized fruit passes through these openings. (Fig. 6.) The size of the openings in each belt corresponds to the size of the apples that are to be separated by that belt. Fruit of the proper size passes down through the openings in the belt, while larger apples are carried on to the next belt in the series. Thus the smallest apples are removed first and the largest last. The sizing units are so arranged that the position of the fruit is changed many times as it passes over the rollers, and uniform sizing is obtained.

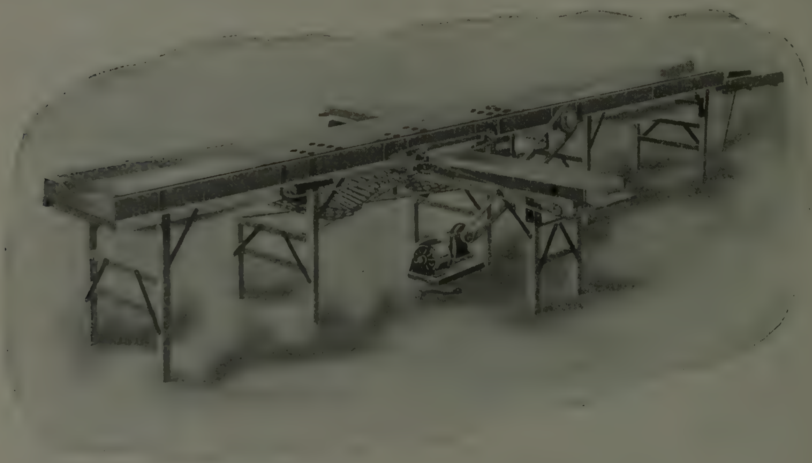


FIGURE 5.—Machine equipped with sizing belts made of linked rings

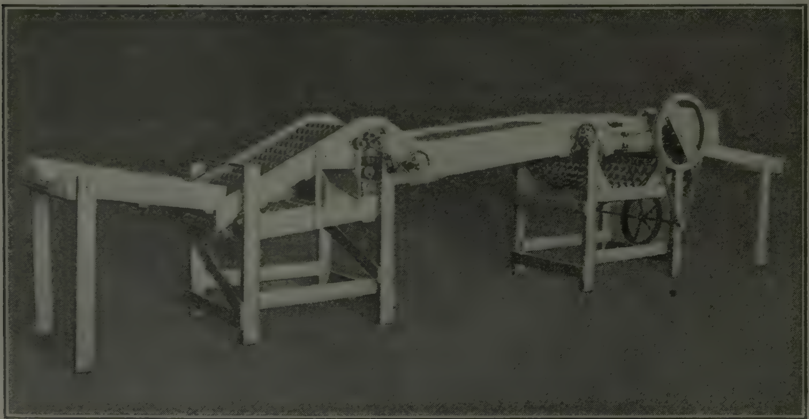


FIGURE 6.—This machine sizes the fruit through round openings in an endless, corrugated roller belt

In another type of machine the fruit is dropped into a series of cups or pockets, operated as an endless belt. (Fig. 7.) These cups or pockets enlarge as the apple is carried along until the diameter is great enough to allow the apple to drop through into the bin. The smaller apples drop through first, and others in order, as the diameter of the cups in which they are carried increases.

In another type of machine the fruit is carried on a belt in a V-shaped trough, and under a series of sizing or ejector wheels revolving on a flexible shaft above. Up-edging brushes suspended over the trough force the fruit to spin rapidly on its cheeks as it moves forward. The spinning motion brings every diameter of the fruit upright as it passes under the ejector wheel so that if the maximum transverse diameter is up to the desired size the fruit will be ejected.

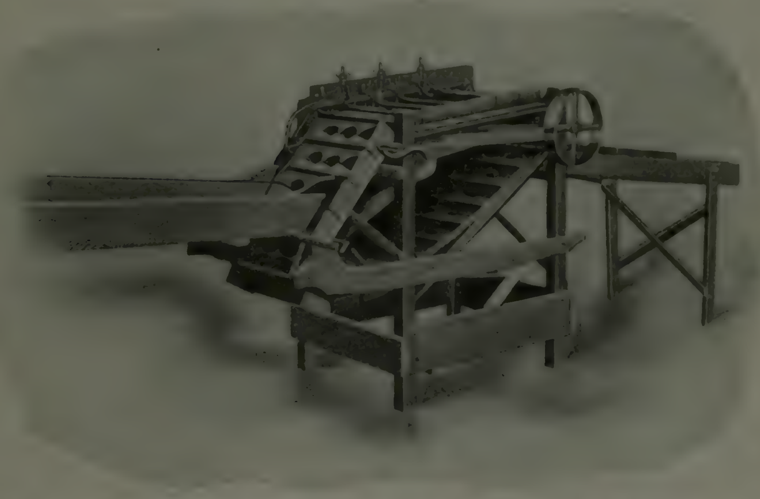


FIGURE 7.—This machine sizes the fruit through cups that enlarge as the belt moves along

A type of sizing machine especially popular in the Western States sizes the fruit according to weight. (Fig. 8.) It is equipped with either a roller sorting section or a canvas belt over which the fruit passes before it reaches the sizing device. Where rollers are used in the sorting section, they are parallel to each other and close together but not in contact. The rollers are wrapped spirally with sash cord so that as they rotate the apples are moved along lengthwise of the rollers and continuously turned so that each apple can be viewed in various positions by the sorters. The apples pass from the sorting section to the sizing mechanism, which consists of an endless chain or belt of small pockets or trays each of which carries an apple as it moves along in a horizontal direction. A tripping device distributes the fruit in bins according to its weight.

In choosing a machine growers should keep in mind that: The machine should have a capacity proportionate to the size of the orchard, so that the operation will be economical; simplicity of design and freedom from too numerous adjustments are much to be desired; durability of the machine is very important since, unless it is substantially constructed, it will soon go to pieces under the rough handling such equipment generally receives; there must be no arrangements or devices that will unnecessarily bruise the fruit. If the apples are bounced along on unpadded parts, or crowded or congested, there is danger that they will be injured and a machine causing such injury is not suited to handling tender varieties of fruit.

ADDITIONAL EQUIPMENT FOR SIZING MACHINES

While many sizing machines now in use are designed to separate only one grade of fruit into its separate sizes, machines that will size more than one grade at a time are now available. By dividing the grading belt lengthwise with a strip or pipe, and rearranging the chutes which divert the fruit from the sizing device to the packing bins, two grades may be sized at the same time. For example if United States Fancy and United States No. 1 grades are to be sized separately, the field-run fruit is emptied on the belt and passes on both sides of the partition; the culls and the fruit that will not grade United States No. 1 are first removed into containers provided for that purpose, then the sorters standing on the United States Fancy side, without handling the United States Fancy grade fruit, put the United States No. 1 grade across the partition, while the sorters on the United States No. 1 side permit the United States No. 1 grade fruit to pass and put the United States Fancy grade across to the other side. Under this plan only 50 per cent of the fruit is handled, no matter what percentage of the crop falls in each grade, except for such handling as may be necessary to ascertain the grade.

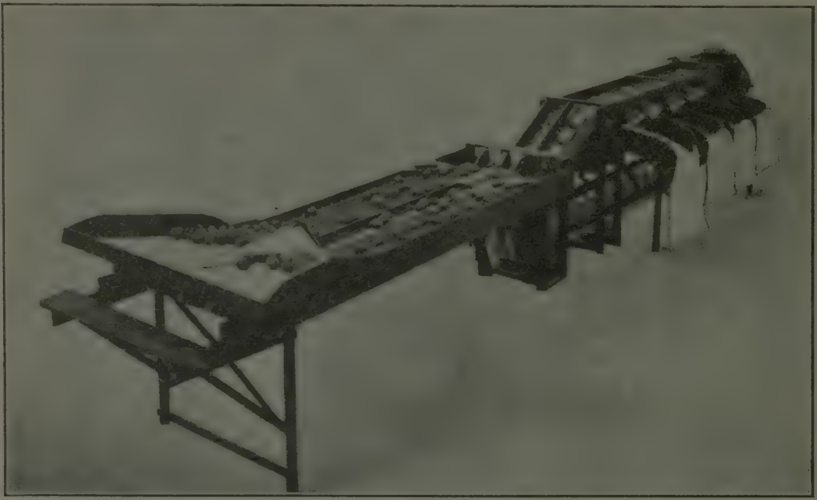


FIGURE 8.—This machine sizes the fruit according to weight. The rollers turn the apples in various positions as they move over the sorting section

Perhaps a better way of dividing the fruit is to divert it all to one side of the partition, then the grade constituting the smaller part of the crop is sorted out and placed on the opposite side of the partition. This requires handling a smaller percentage of the fruit than the other method, unless the crop is evenly divided between the two grades.

In commercial operations the fruit below the grade of United States Commercial frequently is not separated into various sizes, but all above a certain minimum diameter, usually 2¼ inches, is packed together. Some growers include the United States No. 1 grade of 2¼ to 2½ inch size along with the Utility grade to make a combination pack of 2¼ inches and larger.

Instead of following the usual practice of sorting out low-grade fruit into baskets or barrels, a belt conveyor 5 or 6 inches wide, placed about 18 inches above the table, may be used to carry the fruit to a side bin at the end of the machine.

Efficient disposal of culls is often neglected and this fruit is allowed to accumulate on the packing floor where it interferes with the operations of the crew. In many houses the culls can conveniently be carried to the basement through canvas chutes. They must be removed later by elevators unless the house is so constructed that it is possible to drive directly into the basement. If there is no basement, conveying belts can be used to carry the culls to elevated bins, from which they can be removed through a trap into wagons.

The method of feeding the fruit to the sizing machine requires careful study because it influences directly the total daily output and consequently the cost of operation. In the first place, it should be possible to supply a continuous flow of fruit to the sizer without crowding or bruising, and in the second place, it should not be necessary to lift the filled containers to any considerable height above the floor to empty them, especially if the loose fruit is hauled in barrels. Unnecessary lifting may be avoided by elevating the receiving platform or floor above the main packing floor, about 30 inches or a little less than the height of the sizing machine, thus permitting the containers to be emptied at about floor level. If this is done the feeding can be facilitated still further by installing a belt, 10 to 15 feet long, on which to empty the fruit. This belt ordinarily should extend along the receiving platform at right angles to the grading belt, so that the loose fruit can be emptied at any point along the line.

Another method of feeding consists of pouring fruit into a hopper on the floor level, from which it is carried to the sorting belt or sizer by means of an elevator belt. This method has been used where the loose fruit is hauled in barrels, and in some houses has given satisfactory results; however, without careful management there is a marked tendency to bruise the fruit. In the first place, the man emptying the barrels may allow them to rest partly upon the fruit in the hopper; then, when the hopper is full the elevating belt frequently carries several apples halfway up the incline between the lugs, and this fruit is generally bruised by rolling back into the hopper. The hopper method is somewhat slower than the use of a belt running on the level of the machine, because the capacity of a feed belt carrying fruit on lugs several inches apart can not be so great as that of a belt running on the level. If a hopper is used, it must be properly padded.

REMOVING SPRAY RESIDUE

In most of the region in which apples are packed in barrels and baskets, the rainfall during the growing season is usually sufficient to remove most of the spray residue and it has seldom been necessary to wash or wipe this residue from the apples. However, in unusually dry seasons or if sprays have been applied during the latter part of the growing season, it may be necessary to remove the spray residue. In the far West and in some sections of the East, machines are in general use for washing the apples in a diluted hydrochloric acid solution and then rinsing them in water. The washing usually improves the general appearance of the fruit. Machines that wipe the apples with brushes are also used in some sections, and often improve the appearance of the apples. Persons interested in removing spray residue from fruit should consult Farmers' Bulletin 1687 of the United States Department of Agriculture.

POWER

The small machines can be operated by hand power, but in nearly all cases a gasoline engine or an electric motor is preferable.

The speed of the machine needs to be regulated carefully, as the accuracy and care with which the apples are handled are largely dependent upon the speed of the belts and chains. Practically all machines are inaccurate and cause excessive bruising when run too rapidly. When the conveyor belt delivers the fruit to the sizer too rapidly, congestion will result.

CONVEYORS

Two principal types of mechanical conveyors are used extensively in packing-house operations—the endless chain or belt operated by machinery for conveying loose fruit or light packages, and the roller type for conveying filled packages by gravity. Chutes can also be used to advantage to convey fruit (especially culls) or packages to a basement or lower floor. The belts are made of heavy canvas or rubber fabric and are made in different widths. A smooth board or rollers serve as a floor over which the loaded part of the belt travels so that it will not sag or fold under the weight of the fruit. Belts or chains fitted with lugs and supported by a trough, are used to elevate or lower the fruit.

The roller conveyors are convenient in moving fruit in packages from place to place on the packing floor or to a lower floor and are especially useful in unloading containers of fruit from the orchard. Fruit can be carried from one point to another within the house more rapidly and with less labor expense by the use of roller or mechanical conveyors than by carrying or trucking it.

PACKING THE BARREL

The minimum capacity of the apple barrel has been fixed by an act of Congress at 7,056 cubic inches, or somewhat over 3 bushels. Several kinds of wood, chiefly oak, pine, poplar, and birch, are used in the manufacture of barrels. Barrels are usually coopered with six hoops, but in certain localities growers use eight hoops, four instead of two quarter hoops. This insures greater strength, as the single quarter hoops are often broken in handling and a barrel without quarter hoops is likely to be badly sprung. Barrels fitted with double quarter hoops can be stacked more solidly on the bilge, as to a certain extent they are prevented from rocking. Some packers use steel quarter hoops with good results.

The barrel is generally delivered to the grower with both heads and all of the hoops in place, but with none secured by nails. This permits the barrels to be stored indefinitely without warping. When the barrel is removed from storage one head is nailed in and liners, which are thin gumwood strips, are tacked over the ends of the pieces that make the head to prevent them from breaking out of the croze. Each quarter hoop is secured by two or three nails on opposite sides of the barrel. The other head is then removed and placed in the bottom of the barrel. Apples packed in new, clean barrels will usually bring a better price than apples packed in secondhand barrels.

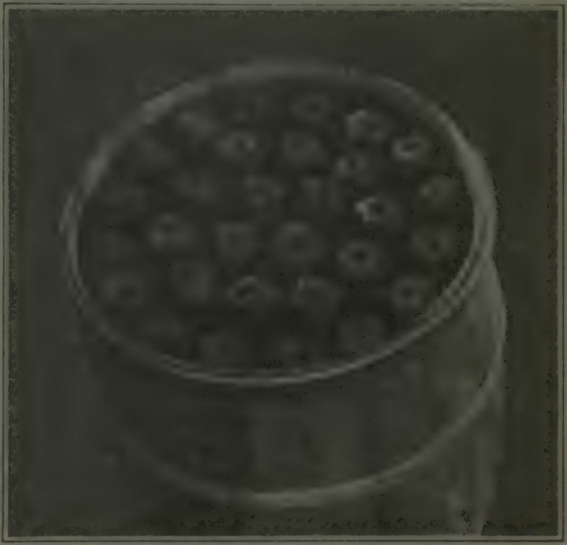


FIGURE 9.—An excellent face made with 2¾-inch apples

FACING

The first step in packing a barrel of apples is facing, or arranging the first and perhaps the second layer of apples in concentric rings on the bottom of the barrel. A corrugated cap, a paper cap, and a paper-lace circle, if it is desired, should be placed in the bottom of the barrel. Apples of uniform size and color and fairly representative of the lot should be selected for the face. They may conveniently be placed in a basket which can be lowered into the barrel and emptied on the bottom. The apples are then arranged in rows around the bottom of the barrel, to form the face of the barrel when it is packed. (Fig. 9.) Practically all growers use the single face, consisting of one layer, but the double face is used occasionally, especially for fancy fruit. The apples are usually packed stems down except that the second layer of the double face is often packed on the cheeks. Single faces are often packed up with a layer of spotters, or apples dropped into the spaces between those in the face, so that the colored cheeks turn downward and show through to the best advantage when the barrel is opened. The spotters also keep the apples of the face in place when the rest are poured into the barrel.

The advantages of the single face are twofold. (1) It legitimately increases the attractiveness of the pack and draws the attention of prospective buyers more readily than if there were no order of arrangement, and (2) if the apples are placed evenly over the surface of the head and are then reinforced by spotters, each one bears an equal amount of the pressure of the head and the bruising is reduced.

The objection to facing is that some packers face with fruit far above the average quality of the barrel in order to deceive the buyer. The United States official packing requirements are that each package shall be so packed that the apples in the shown face shall be reasonably representative of the contents of the package in size, color, and quality.

FILLING THE BARREL

After the barrel is faced it is moved to the packing bin or grading table, where it is filled. Two methods of filling are used almost exclusively because they make it possible to lower the fruit into the barrel with a minimum of bruising. Filling is usually done by the aid of a canvas or burlap apron attached to the grading table or packing bin, but it may be done equally well by lowering half-bushel baskets into the barrel and emptying them.

If the slatted-incline table is used, or if a sizing machine sorts the fruit into packing bins, the apron attachment is employed; but if the fruit is emptied from field crates onto canvas-topped tables and is hand sorted into half-bushel baskets, it is emptied directly from these baskets into the barrel. Either method is satisfactory if the packers employ sufficient care.

The use of shredded oiled paper to prevent scald is recommended when packing varieties which are susceptible to this disease and which are intended for storage. The paper should be used at the rate of about 1½ pounds per barrel, well distributed through the barrel during the packing. For a complete discussion of apple scald and its control, growers should consult Farmers' Bulletin No. 1380 of the United States Department of Agriculture, entitled "Apple Scald and its Control."

A barrel must not only be carefully filled, but packed tightly so that shrinkage and handling in transit or storage will not cause the pack to become slack. To insure a tight pack the apples must be settled thoroughly by racking as they are placed in the barrel.

Racking is the forced settling of the fruit by rocking a partly filled barrel back and forth in a sharp, jerky manner. The racking should be done on a solid floor, preferably concrete. To produce a tight pack the barrel must be racked after the first bushel is poured in upon the face, and again as each half bushel is added, until the barrel is properly filled.

Under no circumstances should a grower omit racking and resort to overfilling to make a tight pack, for no barrel that has been overfilled will pack as tightly as if it had been racked thoroughly to a height nearly level with the top. Pressing an overfilled barrel causes severe bruising all through the pack but does not produce a thorough settling of the fruit. Though apparently tight when pressed, the pack will settle later and become slack. One-half to three-quarters of an inch is usually considered a sufficient height for the contents of a properly packed barrel to extend above the top of the barrel.

TAILING

Before pressing the head into place it is important to level the apples on the tail so that the pressure will be distributed equally. This is done either by leveling off the high places or by arranging all the exposed apples into a plate formation similar to that of the face. The first practice is known as "jumble tailing" and the latter as "ring tailing." (Fig. 10.) The ring tail is used to increase the attractiveness of the pack and also makes possible a tight pack with less injury from the pressure of the head. It is rather difficult for an inexperienced hand to arrange the ring tail successfully, but a week's practice should enable the average person to ring tail 125 to 150 barrels a day.

Tailing is greatly facilitated by using a "follower" or "shaker," a heavy, circular piece of wood made from 2-inch planks with a handle on top and thickly padded on the underside. It is fitted into the head of the loosely filled barrel and held tightly in place during the racking, causing the fruit to settle with an even surface. The follower is applied to the full barrel if the jumble tail is used, but if the pack is ring tailed it is applied before the barrel is quite full, so that the last layer of apples will bring the contents to the desired height, usually one-half to three-fourths inch above the top of the barrel before heading. The follower expedites both methods of tailing.

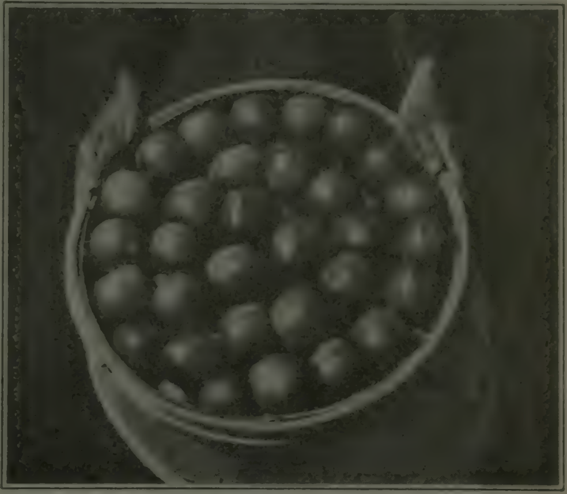


FIGURE 10.—A good example of ring tailing

PADS

Pads, either corrugated or of the "cushion-head" type, are used by many growers to reduce the bruising caused by pressing the head into place. The cushion-head pad is composed of excelsior covered with paper. If two pads are used one is placed under the face as previously mentioned and the other over the tail; if only one is used it may be placed on either end, but will serve best if placed on the tail end, especially when the apples are jumbled and exposed to the rough and frequently uneven pieces of the head, which cut and bruise the fruit when the pressure is applied.

BARREL PRESSES

Two types of press are used for heading barrels. One applies pressure by means of a screw and the other by means of a lever. The screw-type press, (fig. 11) although probably slower than the lever-type press, is greatly superior. It causes less bruising than the lever press because it applies pressure through the screw as a steady force, adjusting the head of the barrel by degrees and without the severe shock caused by the lever press. This difference is important.

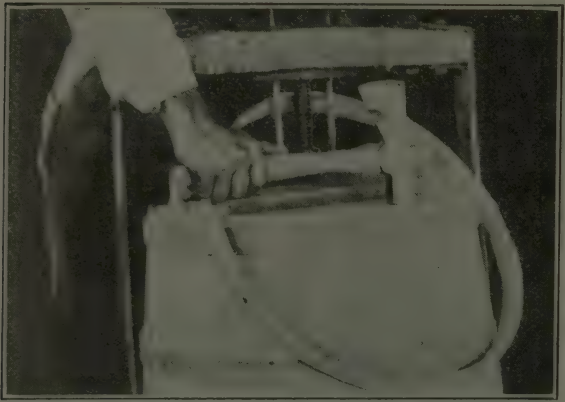


FIGURE 11.—The screw press used for heading barrels

Sometimes a platform on which the barrel rests when it is headed is attached to the screw press. When not equipped with such a platform the press hooks onto the bottom of the barrel by means of iron strips that extend down each side. This arrangement is likely to break the bottom hoops as the head is pulled into place, especially if the barrels are old or damp.

NAILING

When the head has been pressed into place and the upper hoops have been tightened the barrel is ready to be nailed. The nails should not be so large as to split the headpieces and should be driven through the top hoops at an angle of about 45°. Nails driven horizontally into the ends of the headpieces frequently split the wood and do not hold as securely as when driven at an angle. From six to eight nails will hold the 3 and 4 piece heads in place. The use of more is a waste. Many growers use head liners to give additional strength to the pack. This is advisable, especially if barrels are to be transported long distances. The liners are strips of wood nailed over the ends of the headpieces. (Fig. 12.) They tend to prevent the head from springing out of the croze when the pack is submitted to a severe strain.

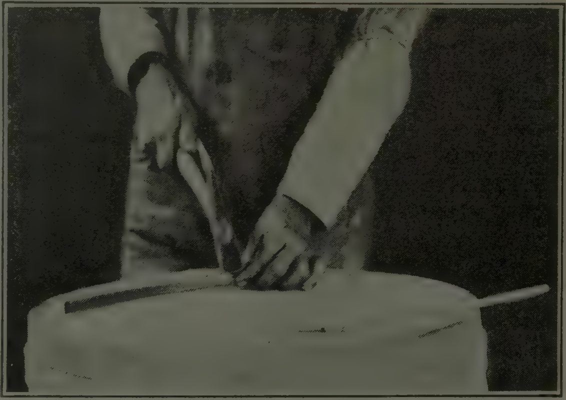


FIGURE 12.—Nailing on the head liners

PACKING THE BUSHEL BASKET

Two general types of bushel baskets (fig. 13) are used as containers for apples: The straight-side type commonly known as the bushel tub; the old-style, round-bottom type. The straight-side baskets are of several different kinds including the continuous stave, the raised bottom, and the loose or removable bottom type.

The straight-side basket is used more than the round-bottom type because it is stronger, gives better protection to the fruit, and stacks better in storage or shipment. The straight-side basket with a raised bottom, which tends to prevent bruising, has been found the most satisfactory type of basket for export shipments. The old-style round-bottom type has been found unsuitable for export shipments. Even for short-distance shipments growers will usually find it to their advantage to use strong, well-constructed baskets that afford ample protection to the fruit. The wire handles should be firmly clinched to prevent their puncturing the fruit.

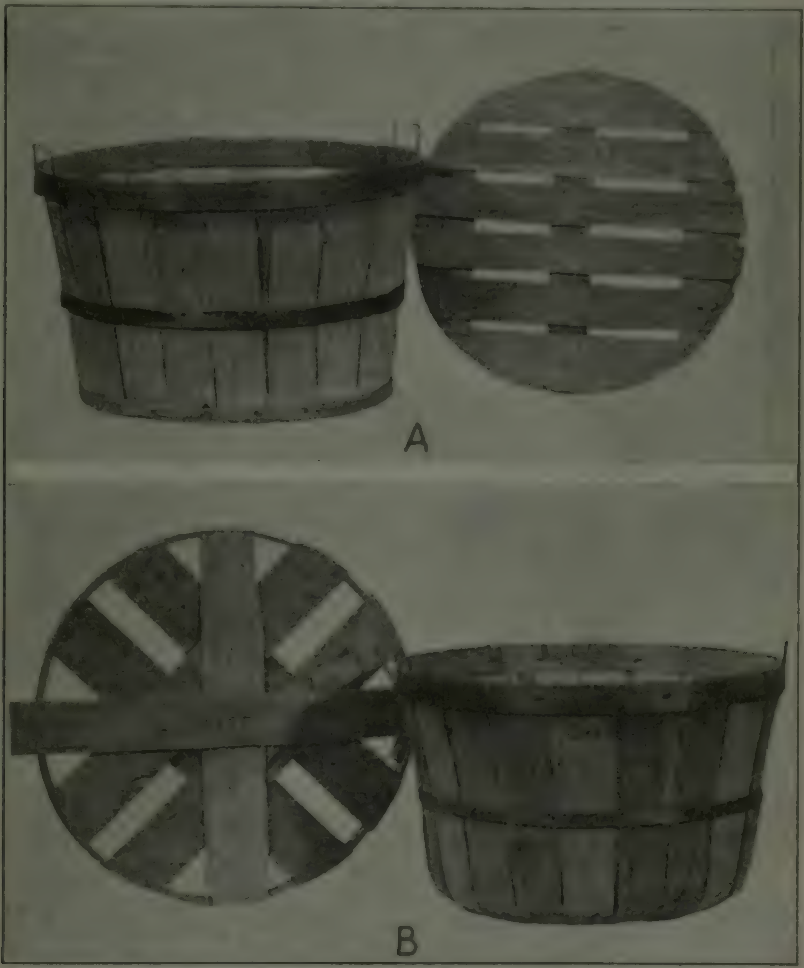


FIGURE 13.—Two general types of bushel baskets are used as containers for apples: A, The straight-side type; B, the round-bottom type

DEVICES AND METHODS OF PACKING BASKETS

Several devices for packing bushel baskets are on the market. With these devices the pack is made in an inverted position. One type of device includes a light, slightly concave, metal facing form. On this form the facing apples are laid in concentric circles, each apple having its stem end or its cheek next the form so that it will be on top when the basket is set upright. A light metal form or shell having the shape and size of a bushel basket, with a heavy paper liner inside it, is placed on the facing form and filled. It is a good practice to place the second layer of apples in the openings between the facing apples to support the face and improve the appearance of the pack. The remainder of the apples are then poured in carefully. The form is racked on a firm base sufficiently during the filling process to insure a tight pack. A canvas or burlap apron attached to the bin helps to prevent bruising the apples as they are poured into the form.

The paper liner holds the pack in place when the packing shell is removed. The basket is then slipped down over the pack and basket and facing form are held firmly together while the pack is turned right side up. Mechanical devices are sometimes used to assist in holding the facing form and the contents tightly in place while the basket is being turned upright. One such device consists essentially of a round crossbar at the middle of a table, supported at each end by posts about half the height of a bushel basket. Hinged to this bar by eyes are two frames each of two parallel L-shaped rods so shaped that they will rest flat on the table, one on each side of the crossbar. The inverted pack rests on one part of the frame and the other part is brought down against the bottom of the basket. By turning the frames from one end of the table to the other the pack is brought to an upright position. The facing form is then removed, a facing pad or corrugated cap is put in place, and the lid is placed on the basket. (Fig. 14.)

Under a slightly different system of packing the face is laid in the basket cover instead of in the facing form. A filling shell and a liner are used. A press which holds the basket and cover firmly together in the inverted position facilitates the proper fastening of the cover with four flat hooks. The basket is not turned upright until the cover has been securely fastened. (Fig. 15.)

In another type of packing device there is a spring-steel packing form with flat fingers, and a metal facing form with a felt center which fits inside the packing form. (Fig. 16.) After the facing form is placed inside the packing form the face is laid and the form is filled with apples. The basket is then placed over the form, and basket and form are set upright. The packing form is then removed while the facing form is held in place with the foot, to prevent disarranging the face. The facing form is then lifted off and the cover is attached. The heavy paper liner is not necessary when this method is used.

One type of basket has a removable bottom. In packing, the cover is first fastened in position, the basket inverted, and the bottom removed. After the face is arranged on the cover, the basket is filled and the bottom fastened firmly in position with five wire loops. (Fig. 17.)

In a well-packed basket the facing layer should be slightly convex and should protrude sufficiently to hold the cover firmly in position and prevent the face from becoming disarranged. Corrugated or cushion-type caps are frequently used under the cover and corrugated pads in the bottom of the basket. (Fig. 18.) The cover should be fastened on securely. Frequently it is held by inserting the projecting cover strips under the wire handles on either side of the basket. Pliable wire hooks midway between the handles are generally used to help hold the cover. In some types of baskets the

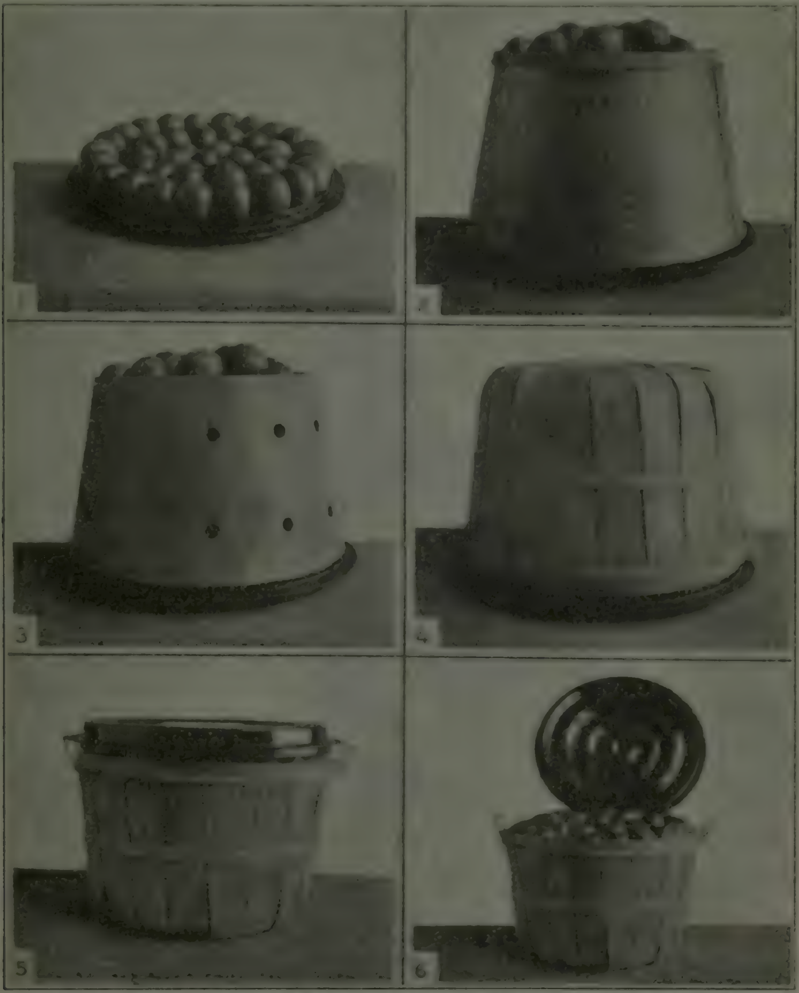


FIGURE 14.—Six steps illustrate this method of packing bushel baskets: (1) The face of the pack is laid in the facing form; (2) the metal packing shell with heavy paper liner inside is placed on the facing form and filled; (3) the packing shell is removed and the pack is held in shape by the liner; (4) the basket is placed over the pack; (5) the basket and facing form are held firmly together and the pack is turned upright; (6) the facing form is removed and the packed basket is ready to have the cover attached

cover is fastened with four or five special hooks instead of by inserting a cover strip under the wire handles.

When baskets are packed in the upright position, they should be well shaken or racked when about half full, to insure a substantial pack. When the basket is filled (except for the facing layer) it should be shaken and a slightly concave follower used in putting the apples in proper shape to receive the facing layer. When the basket is packed, its contents should be high enough to hold the cover tightly in place.

A solid ring pack is used by a few growers for high-quality apples of certain varieties. Under this system the apples are arranged in concentric circles, layer upon layer, until the basket is completely filled. In packing fruit of poor quality, growers have sometimes used the jumble pack without facing.

In packing storage or late-season varieties which are susceptible to scald it is important to use shredded oiled paper, at the rate of about one-half pound per basket, well distributed through the pack, to prevent this disease.

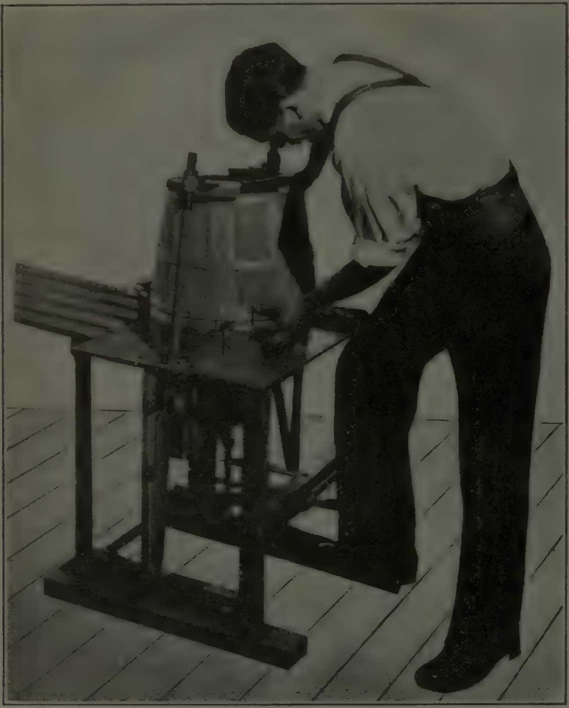


FIGURE 15.—Under this method the basket and cover are held firmly together in the inverted position by a press, while the flat hooks which hold the cover on are attached

MARKING THE CONTAINERS

The barrels or baskets should be plainly marked to show the variety, grade, and size of the apples. The name and address of the grower or shipper are frequently shown also. The marking is usually stenciled on the head of the barrel or the top of the basket. Most States have laws governing marking.

PACKING HOUSES

Most commercial orchardists use packing houses equipped with machinery for grading and packing apples. In small orchards, under favorable weather conditions, apples are often packed in the open with portable equipment, but even small growers find it generally more satisfactory to pack in a house or shed. Even on rough and hilly land where it is difficult to haul the unpacked fruit, packing in houses has proven more satisfactory than packing in the open. In a packing house any accumulation of unpacked fruit is sheltered, and grading and packing can be continued without interruption in spite of unfavorable weather; equipment, packages, and fruit are protected from the weather at all times; use of a house encourages the installation of sizing machinery and other labor-saving devices which can not be used to advantage in the open; and efficient organization of labor is simplified by having all of the work done in one place and avoiding the unnecessary confusion and loss of time caused by moving the outfit frequently.

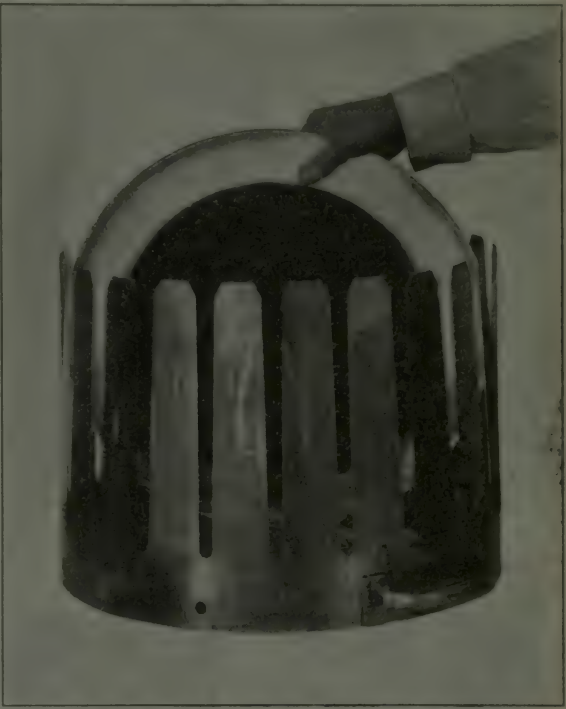


FIGURE 16.—In this packing device the face is laid on the facing form with felt center after the form has been placed in the packing shell. The face of the pack is held in position by the facing form while the packing shell with the flexible steel fingers is being withdrawn from the basket

Community packing houses operating cooperatively or as private enterprises are used in some producing districts. Their use is conducive to a uniformity in grade and pack of apples shipped from the district that is desirable from a marketing viewpoint. Economies in operation and lower costs per package for grading, sizing, and packing are often possible in community packing houses because of the large volume, good machinery and equipment, and well-trained and supervised help. Improved roads and the concentration of commercial orchards in limited areas favor the success of community packing houses.

Many types of structures, ranging from tents and sheds to permanent buildings equipped with packing machinery, are used in apple packing. The most desirable type is determined largely by the size of the orchard and the section in which it is located. In many places where individual orchards are too small to justify the erection of modern packing establishments, such houses have been built and successfully operated as community enterprises.

Packing houses can best be classified according to their equipment. Those with no labor-saving devices other than those used to fill and head the barrels are in one class; those equipped with sizing machines, gravity and belt conveyors, and other mechanical devices, constitute another class, regardless of the extent of floor space or the construction of the building in either case.

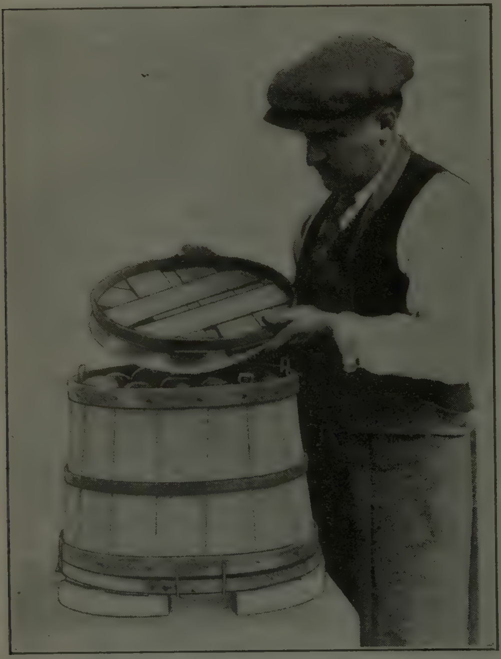


Figure 17.—The bottom of this basket is removable and is fastened in position after the basket is packed

LOCATION

In choosing the site for a packing house several points are important. A community house, practically without exception, should be located on a railroad to avoid the added expense of hauling the packed fruit to the railroad.

If the packing house is located at the orchard, its position depends largely upon the lay of the land. If the land is generally level it is sometimes better to have the house in the middle of the orchard, thus reducing to a minimum the aggregate distance for hauling the unpacked fruit. When the road to the shipping station is good and permits hauling heavier loads than can be pulled through the or-

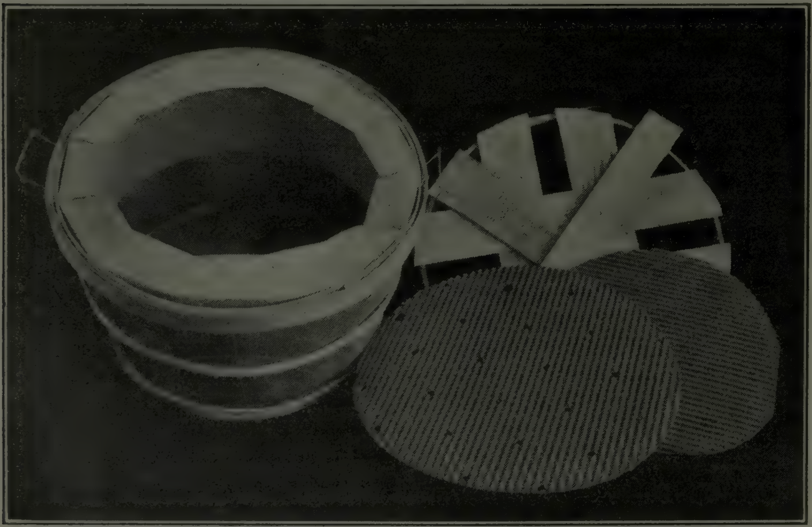


Figure 18.—Straight-side bushel basket with cover, corrugated pads for top and bottom, and liner of the type extending part way down the side of the basket and overlapping on the face of the pack

chard, the house should be placed on this road. In a hilly orchard the house should be located where there is a minimum of uphill hauling.

If basement storage is desirable, advantage can sometimes be taken of a slope to build a house having the receiving platform level with the wagon beds on the upper side and the floor of the basement level with the wagon road on the lower side. Under this arrangement the fruit can be conveyed to the basement by gravity and removed without elevators.

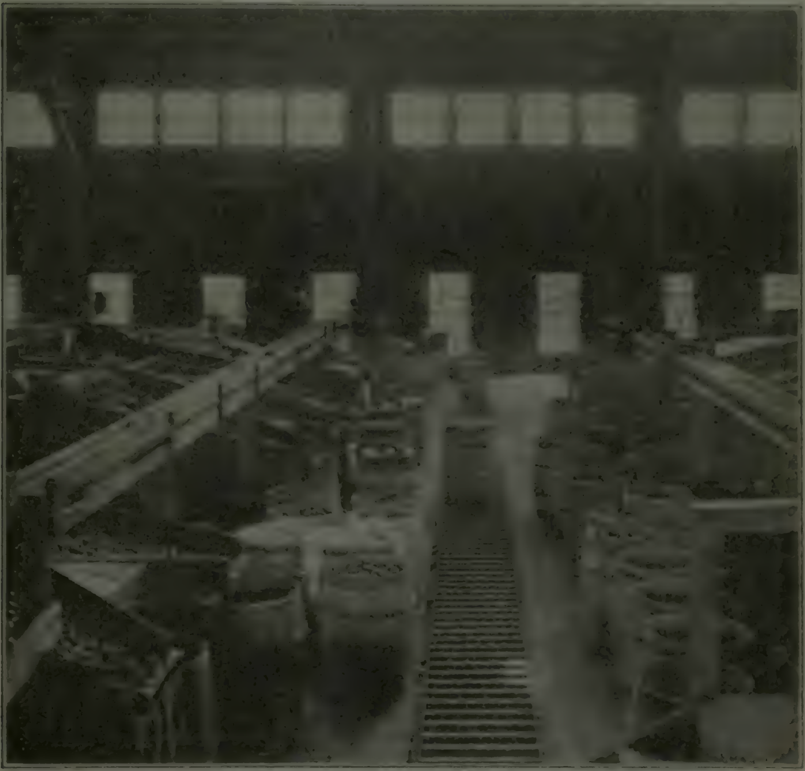


FIGURE 19.—In this packing house there is adequate light. A roller conveyor is used to move the filled barrels from the packing bins

LIGHTING

In constructing a house or remodeling an outbuilding for use as a packing plant, providing for an abundance of light is of first importance, for the thoroughness of the work is severely impaired if the fruit is partly in shadow. Skylights and windows high up on the walls in sufficient number to light the interior thoroughly offer the most satisfactory lighting arrangement. (Fig. 19.) If there is a loft, skylights can not be used except by adding light shafts. The sides of the shafts should be painted white to increase the illumination of the packing shed. A large house that depends upon side illumination is likely to have a dark area near its center, even though the sides may be entirely open, but if all tables and conveyor belts used for sorting are placed along the sides of the house the light will fall directly on them.

If artificial illumination is used at any time, special care should be taken to arrange the lights for the sorting operations so that there will be no shadows on the fruit. For this purpose reflectors consisting of inverted troughs fitted with electric bulbs can be suspended over the grading belts or tables.

STORAGE ACCOMMODATIONS

Every packing house should have adequate space for storing empty packages, for temporary storage of loose fruit from the orchard, and for packed fruit intended for cold storage or shipment.

If 50 per cent or more of the packages needed for the crop can be stored in the house at one time, there is little danger of shortage and consequent necessity to suspend operations during the height of the season, as frequently happens when it is planned to obtain the packages from day to day from a local cooperage.

A loft or second story immediately over the packing floor is sometimes used as a storage for empty barrels or baskets but makes it difficult to supply adequate light in the packing room. A shed adjacent to the packing shed is perhaps the most satisfactory place for storing empty containers. If barrels are stored on the packing floor, the house must be unusually large to accommodate them without congestion and confusion.

A wide receiving platform or the floor space adjacent to the feeding belt should be used for storing enough field-run fruit to supply the crew for several hours or longer, so that temporary interruptions in the delivery of fruit from the orchard will not interrupt packing operations.

It is also well to provide room for at least one day's output of packed fruit awaiting movement. A shortage of cars or of hauling facilities frequently prevents removing the fruit as rapidly as it is packed; space should be provided to accommodate such fruit temporarily without hindering the packing operations. Such space can be provided satisfactorily in a basement, particularly if the shed is built on sloping land, so that the packed fruit can be loaded on trucks from the basement level.

VENTILATION

Adequate ventilation throughout all parts of the house, especially those parts intended for temporary storage of fruit, is important. The main packing room seldom lacks ventilation because of the number of windows required for proper lighting.

SUGGESTED FLOOR PLANS

It is impossible to give here the exact specifications for building packing houses, but with the aid of several suggested floor plans certain desirable features of construction and arrangement for the convenient and economical handling of fruit may be pointed out. In planning the construction of any packing house the space near the sorting and packing operations should be kept as free as possible from supporting timbers.

The type of house suggested in plan 1 is designed for packing by hand over ordinary apron or canvas-top tables. (Fig. 20.)

The dimensions of this house are 30 by 60 feet, which, with a double-apron table, should provide for an output of 200 barrels per day. For larger operations the floor space and the number of units can be increased indefinitely. The house is divided into two sections, one to be inclosed for storing empty barrels or baskets and the other to be left open on two sides for packing. The space available for packing operations is increased by adding two covered platforms 5 feet wide, extending along the open sides of the packing room. The driveways should be built so that the truck or wagon beds will be level with these platforms to facilitate loading and unloading. The fruit is received on one platform and passes through the packing operations to the other side of the house, where it is loaded on trucks. The equipment is so arranged that the work can be done without waste motion. Extra space in the packing room is provided for unpacked and packed fruit.

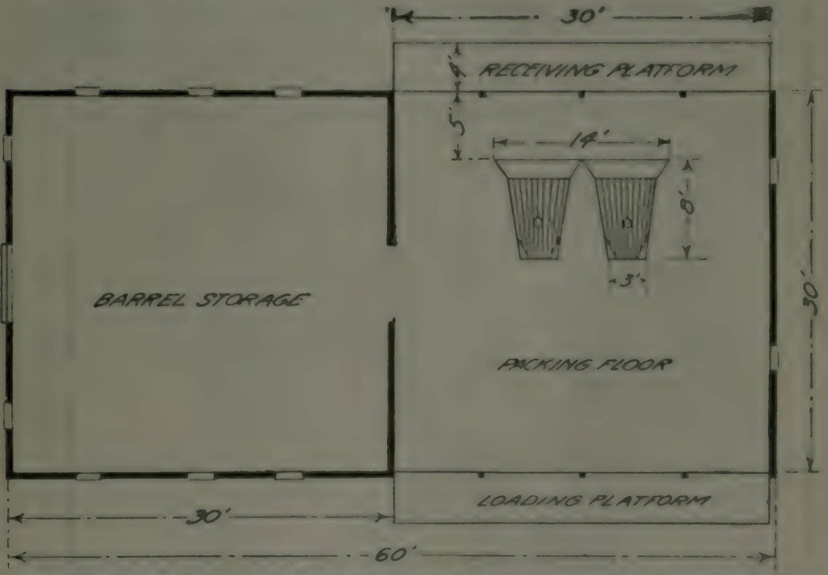


FIGURE 20.—Plan 1: Floor plan of a packing house designed for packing by hand

Plan 2 shows a house equipped with three grading machines which have a total capacity of approximately 1,200 barrels a day. (Fig. 21.) This arrangement is particularly well adapted to a community house in which fruit is packed for a number of growers. The feeding belts marked A are very desirable, making it possible to empty fruit on the machine from practically any point along the receiving platform. The fruit passes over the sizing chain B, where any apples smaller than the minimum size for packing are dropped into a cull chute C leading to the basement. The remainder of the fruit is then delivered to the grading belt D, where the badly defective apples are culled out by the sorters and dropped into another branch of the cull chute. The grading belt may be divided as illustrated in the center machine so that two grades can be sized simultaneously. In this case the sorters who work on both sides of the grading belt divide the fruit into two grades, which may be United States Fancy and United States No. 1, and which are placed on opposite sides of the division board E. Usually the fruit from 2¼ to 2½ inches in diameter passes through the rings marked F into the bins G and GG. But the fruit 2½ inches in diameter and larger is carried up the elevator belt H onto another belt I, which delivers the Fancy fruit into bin J and the United States No. 1 fruit into the double bin K. This bin is fitted with a gate or deflector L, which when open fills the first compartment and when closed allows the second compartment to fill. Two bins are provided for this fruit because the bulk of the average crop grades United States No. 1, 2½ inches and larger, and there must be bin space enough to accommodate all this grade when operating the machine continuously. If a third grade such as United States Utility, is to be packed, this grade would have to be picked off the sorting belt into baskets or placed on a special conveyor belt.

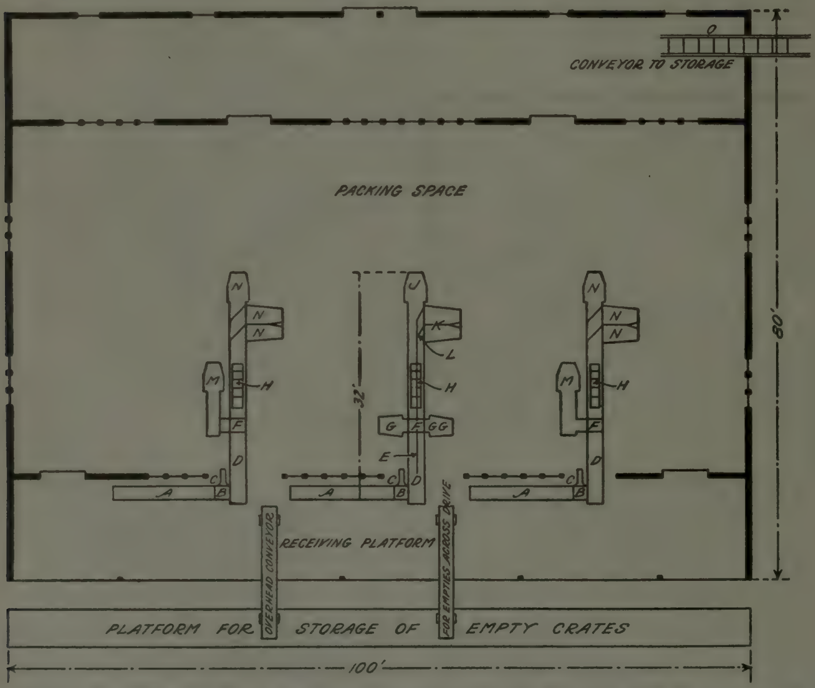


FIGURE 21.—Plan 2: Floor plan of a community packing house with a capacity of 1,200 barrels a day

The end machines indicated in this plan are not equipped to size two grades. Fruit of quality other than United States No. 1 is removed from the sorting belt into baskets and packed in the space behind the sorter, while the United States No. 1 fruit from 2¼ to 2½ inches in diameter passes through the sizing chains F and is conveyed into bins M. The bulk of the crop, which is United States

No. 1 grade, 2½ inches and larger, is distributed among the three bins N. If United States Commercial or other grades are to be packed, it may be necessary to vary the sorting and sizing operation accordingly.

After the containers are packed they are passed to the platform in the rear of the house, and from there may be transferred by means of the conveyor O to storage or loaded on trucks or cars. This house is equipped with two overhead conveyor belts for carrying empty crates across the drive from the main packing floor to the platform for storage of empty crates. This arrangement keeps the whole area of the receiving platform always available for incoming fruit.

A loft may extend over the whole packing floor for barrel and basket storage, if adequate light shafts are provided. The containers may be coopered and stenciled here and lowered through shafts to convenient points on the packing floor. (Fig. 22.)

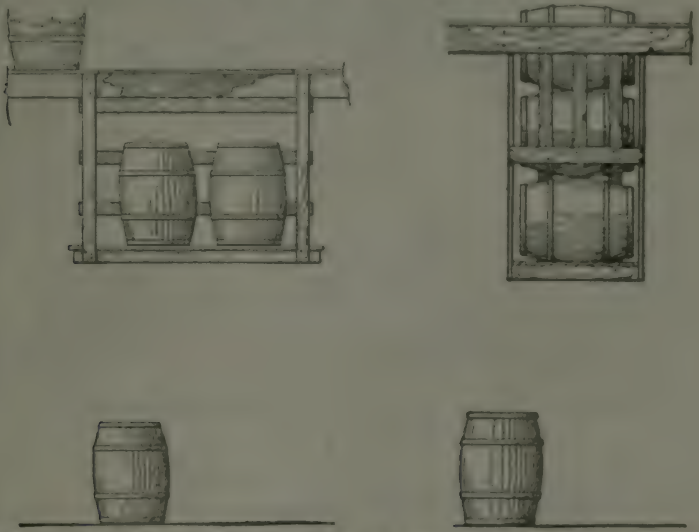


FIGURE 22.—Two desirable methods of lowering empty barrels from loft to packing floor

Plan 3 shows a house equipped with two grading machines having a total capacity of 1,000 barrels a day. (Fig. 23.) The fruit is delivered on a receiving platform which extends the total length of the house. It is emptied from the orchard containers onto the conveyor belt A at any point along the platform. This conveyor belt is built 8 inches above the receiving platform, which greatly facilitates the emptying of the crates. The receiving platform B is 48 inches above the level of the packing floor. The sorters, indicated by × in the diagram, work on the platform C, which is elevated 18 inches. The sizing belts are 56 inches above the packing floor, which makes it possible to deliver the fruit directly from the sizing chains into the packing bins by gravity. As the fruit passes over the first sizing rings at D all the apples under the minimum size for packing drop into a chute which delivers them into a pile outside the building. The packing bins F, G, H, and I are used for various sizes of fruit.

Apples of the various sizes selected for facing are carried to facing bins J. The container storage should be located in a loft over the packing floor where the barrels are coopered and placed in racks L, from which they are removed by the persons doing the facing. Packed containers awaiting shipment may be stored temporarily on the covered platform M.

Plan 4 embodies many features of a conveniently arranged packing house. (Fig. 24.) The over-all dimensions of the house are 40 by 50 feet, with a total capacity of approximately 500 barrels per day. These dimensions can be changed to provide a larger space for the storage of unpacked and packed fruit. The actual floor space occupied by the packing machinery is 20 by 30 feet. Empty containers are stored in a large loft over the packing floor. Barrels are coopered in the loft and as needed are let down through the shafts A. This arrangement avoids accumulation of empty containers on the floor of the packing house to interfere with the operations of the crew.

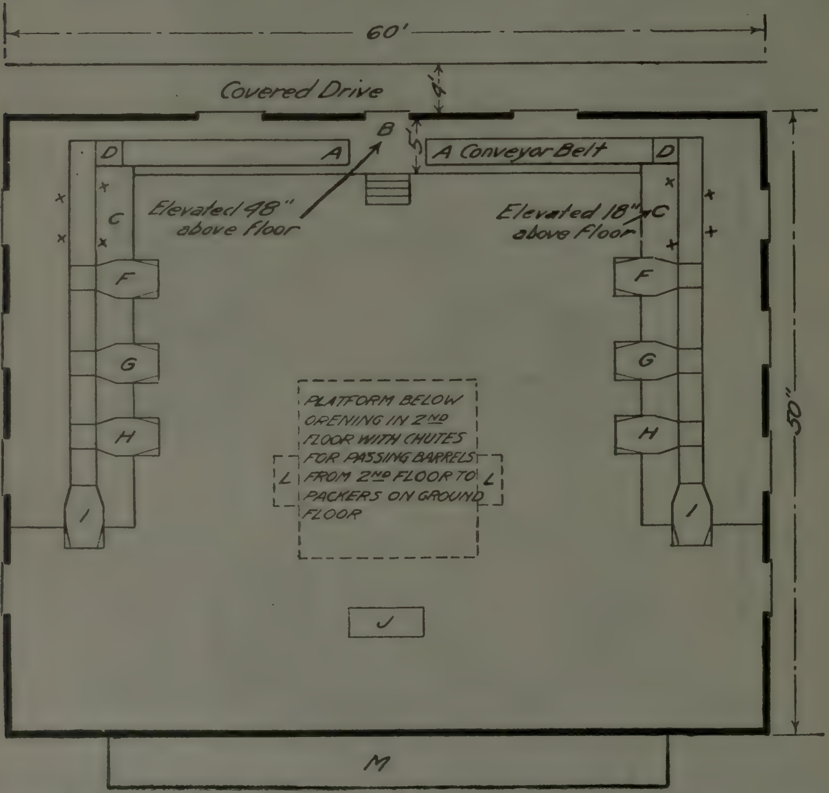

60'
Covered Drive
4'
B
D
A
A Conveyor Belt
D
C
Elevated 48" above floor
Elevated 18" above Floor
C
F
F
G
G
H
H
I
I
PLATFORM BELOW OPENING IN 2ND FLOOR WITH CHUTES FOR PASSING BARRELS FROM 2ND FLOOR TO PACKERS ON GROUND FLOOR
L
L
J
50'
M

FIGURE 23.—Plan 3: Floor plan of a well-arranged house capable of handling 1,000 barrels daily

The fruit-receiving floor is 30 inches above the rest of the floor. The receiving space is enlarged by the addition of a 4-foot outside platform extending the width of the house. The feed belt B, 18 feet long and 2 feet wide, is 18 inches above the receiving floor. The feed belts of some grading machines are approximately $3\frac{1}{2}$ feet above the floor, but it is impracticable to empty barrels on a belt at this height. The fruit passes from the feed belt to the first sizing rings, where all fruit smaller than $2\frac{1}{4}$ inches is graded out. The larger fruit passes to a grading belt C, which is 7 feet long and accommodates six sorters. This belt is divided by a partition, so that as the fruit passes, the Utility grade is sorted out and diverted into the first bin. The culls are thrown into two chutes E leading to the bin outside the house. The United States No. 1 grade fruit passes to the

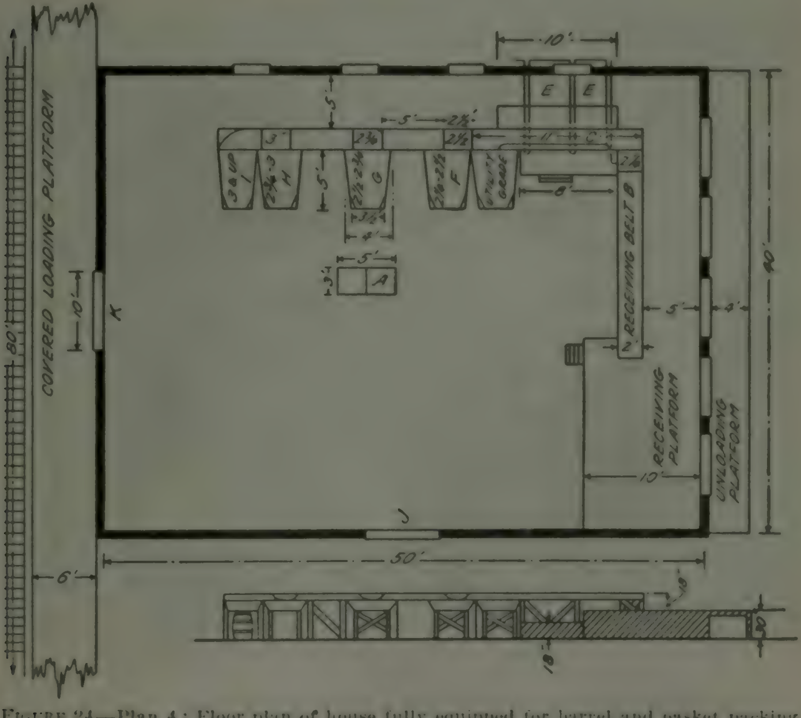


FIGURE 24—Plan 4: Floor plan of house fully equipped for barrel and basket packing

next sizing rings, where the fruit $2\frac{1}{4}$ to $2\frac{1}{2}$ inches in diameter is dropped into bin F. The remainder of the fruit is separated according to size into bins G, H, and I. Sorters stand on a raised platform 18 inches above the floor level. The sizing belts are 48 inches above the floor, high enough to provide the proper drop to the packing bin. The fruit is loaded on the cars from a covered platform 6 feet wide and 80 feet long.

At the receiving end of the house there are doors hinged at the top to swing outward and upward. When open, these doors form a cover for the platform and leave the receiving floor free from obstruction. There are also sliding doors at J on the side of the house and at K in the rear. Windows in the sides of the house, together with the doors, furnish light for the packing operations.

HAULING

Since much of the apple crop marketed in barrels and baskets is packed at the orchards, it is usually necessary to haul the packed fruit to the shipping point, sometimes several miles away. This hauling must be done as rapidly and cheaply as possible and with a minimum of damage from shaking the pack and bruising the fruit. Careful handling of the packed fruit is as important as care in any of the packing operations. Damage caused by bruising results in price discounts on the markets. A rough, jolting haul frequently impairs the rigidity of the package so much that it will not withstand the strain of transit.

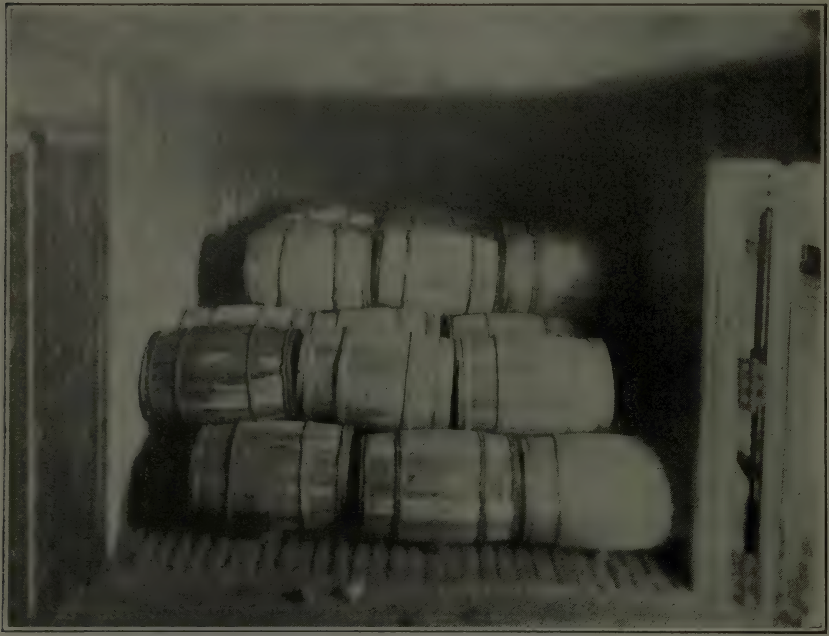


FIGURE 25.—A satisfactory and widely used method of loading barrels

Motor trucks are best suited for such hauling because they combine speed, large capacity, and smooth carriage. Trucks can be fitted with racks which make it possible to haul larger loads than are possible in the truck beds.

LOADING IN CARS

A good system of loading in cars must provide for the even distribution of the strain on the barrels or baskets, and these containers must be stacked tightly enough to avoid shifting and breaking. The most popular and probably the most satisfactory method of loading barrels is known as the alternating-straight load. (Fig. 25.) This load is started by placing two rows of three barrels each, end to end, across the car, which leaves a space of about half the length of a barrel at the end of the rows. The second layer is then started by placing a row of three barrels on top of the first two rows, but starting from the opposite side of the car and covering the open space between the ends of the rows below and the side of the car.

The remainder of the car is loaded in the same way, alternate layers being started from opposite sides of the car. By this method long channels are formed along the walls lengthwise of the car and serve as flues for the circulation of air. When cars are shipped under refrigeration a load stacked in this way cools more quickly, and if a ventilated car is used there is a free circulation of air throughout the car. An additional advantage is that the bilge of one barrel does not rest directly upon the bilge of another, but in the hollow space over the ends of four barrels below. In some instances the barrels are loaded irregularly between the doorways for convenience in loading; sometimes they are stood on end.

In loading a car with bushel baskets, perhaps the most common and satisfactory method is to begin by placing a row of baskets the entire length of the car. Baskets should be placed so that the top hoops are in tight contact with each other and the handles should be placed diagonally to the side of the car. (Fig. 26.) The second layer is placed on the first so that the baskets in the second layer are not centered directly on top of the baskets in the lower layer, but each rests on two baskets in the lower layer. Except for early-season shipments it is customary to load the cars four layers high. The first row, four layers high the entire length of the car, is usually loaded before the second row is started. Each basket in the second row, which is started from the other end of the car, fits against two baskets in the first row. This process is continued until the car is loaded. The last two rows in the car are usually built up together, beginning at the ends of the car and working toward the door. In a 33-foot car, 22 baskets can be loaded lengthwise, with 6 baskets across the car, and 4 layers high, making a load of 528 baskets.

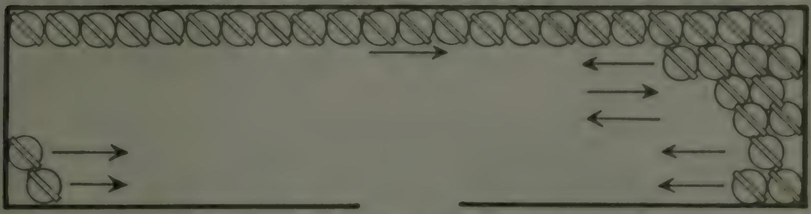


FIGURE 26.—Floor plan of car, showing a good method of loading apples packed in baskets. The arrows indicate the direction from which the rows (usually four baskets high) are stowed. The handles are placed uniformly diagonal to the side of the car

COLD STORAGE

In order that apples shall reach the market in the best condition, those not intended for immediate marketing should be placed in cold storage as soon as possible after they are packed. If the fruit is allowed to remain for some time at a rather high temperature it will become mealy and will lose in market value much sooner than does fruit placed in cold storage immediately. This is particularly true of some of the more tender varieties. The ideal range of temperature for storage of most varieties is about 30° to 32° F., and this range can not be maintained in common storage. Cold-storage facilities for a large part of the crop are available in many of the important producing areas. The large markets are also well provided with these facilities.

GRADING LAWS AND INSPECTION

As far as the Federal Government is concerned the use of the United States grading standards is optional with growers and shippers. Tentative United States grades for apples were first recommended in 1918. In 1924, they were promulgated by the Secretary of Agriculture to be the official standards of the United States for the inspection and certification of barreled apples. Since that time the standards have been revised from time to time in accordance with the requirements of the industry.

The United States standards are in general use in the region east of the Rocky Mountains. At the beginning of 1932, 15 States had compulsory grading laws based on either Federal or State standards. Only one of these States, however, provided for compulsory inspection of all apples for shipment.

Inspection of apple shipments by Federal-State inspectors is available for a small fee in most of the important apple-shipping districts. Certificates giving a statement of the grade and a description of the shipment are furnished to the interested parties as a part of the service. For the year ended June 30, 1931, 24,237 cars were inspected under the Federal-State service at shipping points in the region that ships mostly barrel and basket apples. This represents about 47 per cent of the car-lot apple shipments from this region. The Federal inspection service is also available in the important markets; here for a small fee inspection can be had upon request by financially interested parties.

The use of the United States grades and the inspection service furnishes a basis for sale to distant buyers and for contract transactions and discourages the rejection of cars without just cause upon arrival at the market. A record of grade, together with a description of the shipment, including variety and size of fruit, such as is furnished by an official inspection certificate, facilitates settlement of any claims against transportation companies. Grading and inspection of apples under the United States standards encourage improvement and uniformity in grade and pack, which is beneficial to the industry.

U. S. GOVERNMENT PRINTING OFFICE: 1933

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1696

DECIDUOUS-FRUIT IMPROVEMENT *Through* TREE-PERFORMANCE RECORDS

SUCCESSFUL COMMERCIAL production of deciduous fruits is based upon the culture of established, profitable varieties. Systematic individual tree studies of many orchards, particularly those where the trees have just come into bearing, may reveal inferior or off-type trees that reduce profits. These undesirable trees may result from the unintentional propagation of limb variations, from the failure of the buds inserted in the nursery rootstocks, or from accidental mixture of strains or varieties in the nursery. Such trees can be located and their characteristics studied through the individual-tree performance record method described in this bulletin, and if necessary they can be eliminated by replanting or top-working.

Individual-tree performance records are useful in selecting superior trees as sources of bud wood for propagation, in finding valuable limb variations that may give rise to improved strains or varieties, in locating undesirable limb variations to be removed by pruning, in studying the results of orchard practices or experimental tests, and in the systematic care of individual trees.

In deciduous fruit orchards such records are most important as a means for discovering the relations of cultural practices, inherent tree characteristics, and environmental influences to profitable orchard production. It is believed that they will help materially in revealing the causes of failure to obtain satisfactory quantity and commercial quality of fruit and in indicating the best methods of improving yields.

The individual-tree performance records of citrus orchards have been outstandingly useful, both commercially and scientifically. The records have been widely adopted by citrus growers of the Southwest as one of the regular orchard practices. It is believed that a somewhat similar method of individual tree study will prove equally valuable in deciduous fruit orchards.

Washington, D. C. Issued January, 1933

DECIDUOUS-FRUIT IMPROVEMENT THROUGH TREE-PERFORMANCE RECORDS

By A. D. SHAMEL, *Principal Physiologist*, and C. S. POMEROY, *Associate Pomologist, Division of Horticultural Crops and Diseases, Bureau of Plant Industry*

CONTENTS

	Page
Variations in deciduous-fruit trees	1
Classification of variations	2
Searching for bud variations	6
Obtaining individual-tree records	7
Individual-tree numbers	8
Record forms	10
Field records	11
Performance-record periods	12
Assembling data from field records	12
Using individual-tree records	14
Isolating and propagating superior strains	15
Locating unprofitable trees	15
Making progeny tests of selected parent trees	15
Comparing cultural practices	16
Establishing reliable commercial sources of propagating material	17

TO AN EVER-INCREASING EXTENT, deciduous fruits are produced commercially from comparatively extensive plantings of a few established varieties in orchards that are operated under scientific methods, with systematic attention given to even the smallest details of cultural practices. Every tree should be given individual care in order to raise the average production as high as possible. Some system of recording the performances of individual trees is desirable in order to determine definitely which trees are unproductive or otherwise undesirable. The purpose of keeping individual tree performance records in deciduous-fruit orchards is to obtain definite data on production and other characteristics of individual trees.

VARIATIONS IN DECIDUOUS-FRUIT TREES

Off-type trees occur in most young plantings. In some instances they have been numerous, 2 per cent or more, and have necessitated expensive top-working or replanting. Some come from unintentional mixture of varieties by nurserymen; the rest have usually been accounted for as being caused by buds, inserted in seedling rootstocks failing to grow. Such trees are commonly called seedlings, on the theory that they have actually developed from the seedling stock instead of from the inserted buds.

However, investigations of extensive plantings of young peaches, pears, prunes, and apricots have indicated that in some instances the off-type trees are not seedlings but the results of unintentional propagation of limb variations that occurred on the parent trees from which the bud wood was obtained. The fruit and foliage characteristics of some of these off-type trees resemble very closely those of certain limb variations in trees otherwise normal and indicate that the tree variations probably resulted from accidental propagation of similar limb variations.

Therefore, in the propagation of deciduous fruits, consideration of limb variations becomes highly important. In citrus varieties propagations from the normal branches of trees in which limb variations occur are likely to produce variable progenies. Some of these progenies will bear varying quantities of fruit like that of the limb variations in the parent trees, and others will produce only the abnormal type of fruit. It seems probable that this is also true of deciduous fruits and explains the origin of some of the off-type trees.

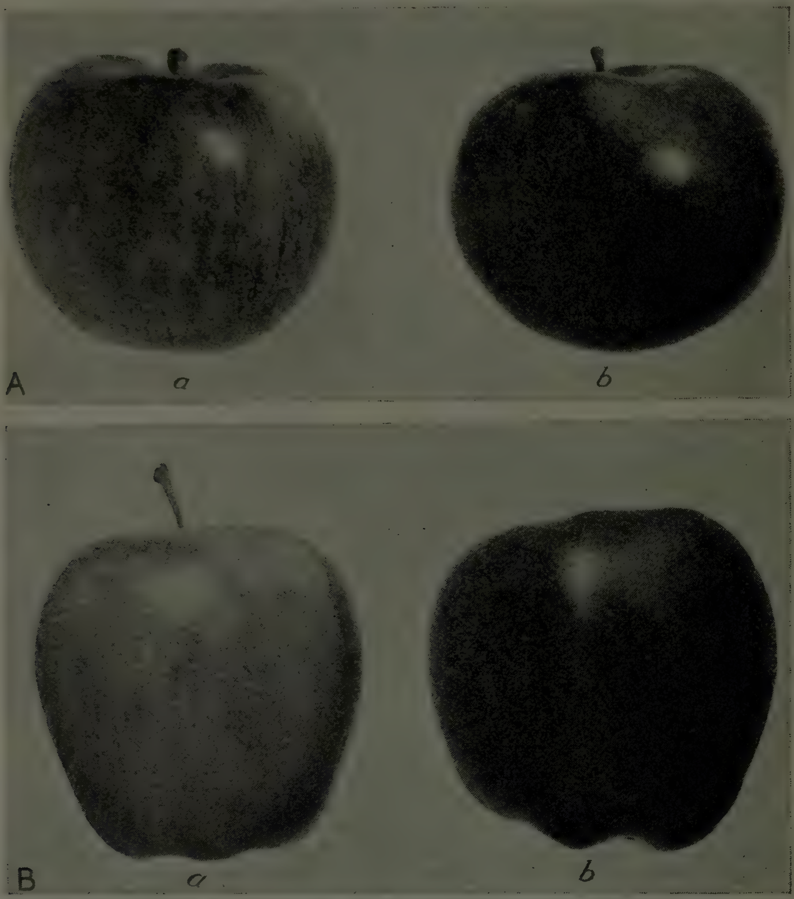


FIGURE 1.—A, McIntosh apples from tree at Fennville, Mich.: *a*, Normal fruit; *b*, solid red fruit borne on limb variation. B, Delicious apples from tree at Wenatchee, Wash.: *a*, Normal fruit; *b*, solid red fruit borne on limb variation

CLASSIFICATION OF VARIATIONS

Variations may be classified as: (1) Fluctuations, which are not stable but are probably caused by climate, soil, cultural practices, or some other environmental influences; and (2) true variations, which may consist of a branch, limb, or an entire tree. These latter are not caused by environmental conditions and may be perpetuated by budding. They are called "bud variations" and in those most commonly observed the characteristics of the fruits or foliage offer striking contrasts to the normal.

Bud variations may, from the grower's standpoint, be superior or supplementary to the true or normal variety, or they may be inferior. The red strains of the Delicious and certain other apple varieties, for example, originated as bud variations; their earlier, more uniform, or deeper color makes many of them more desirable than the normal-type fruits of these varieties. Fruits of red strains of the McIntosh, Delicious, Jonathan, and Winesap apples, which originated as limb variations, are shown in Figures 1 and 2. Inferior variations may cause loss in grade and quality, and increased cost of sorting and packing. Continuing to propagate them unintentionally may produce large and increasing numbers of off-type trees in the variety.

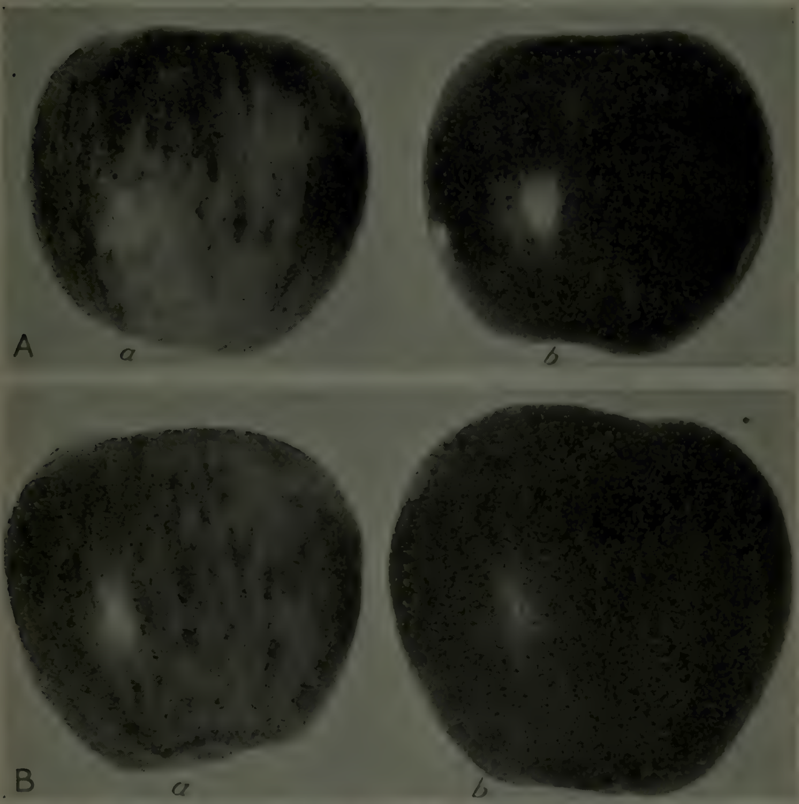


FIGURE 2.—A. Jonathan apples from tree at Wenatchee, Wash.: *a*, Normal fruit; *b*, solid red fruit borne on limb variation. B, Winesap apples from tree at Wenatchee, Wash.: *a*, Normal fruit; *b*, solid red fruit borne on limb variation

A bud variation of a Sims peach tree near Merced, Calif., and the progeny trees propagated from it, bear peaches that mature about two weeks earlier than those borne by comparable normal Sims trees. This early maturity extends the harvesting season and the variation is a valuable supplementary strain. Figure 3 shows fruits from both the normal part of the tree and the variation.

An unproductive bud variation occurred on an otherwise normal Tuskena (Tuscan) peach tree in the same orchard, and the progeny trees propagated from it are almost entirely barren. This unproductive strain, wholly worthless for commercial culture, is an example of an undesirable strain originating from a bud variation.

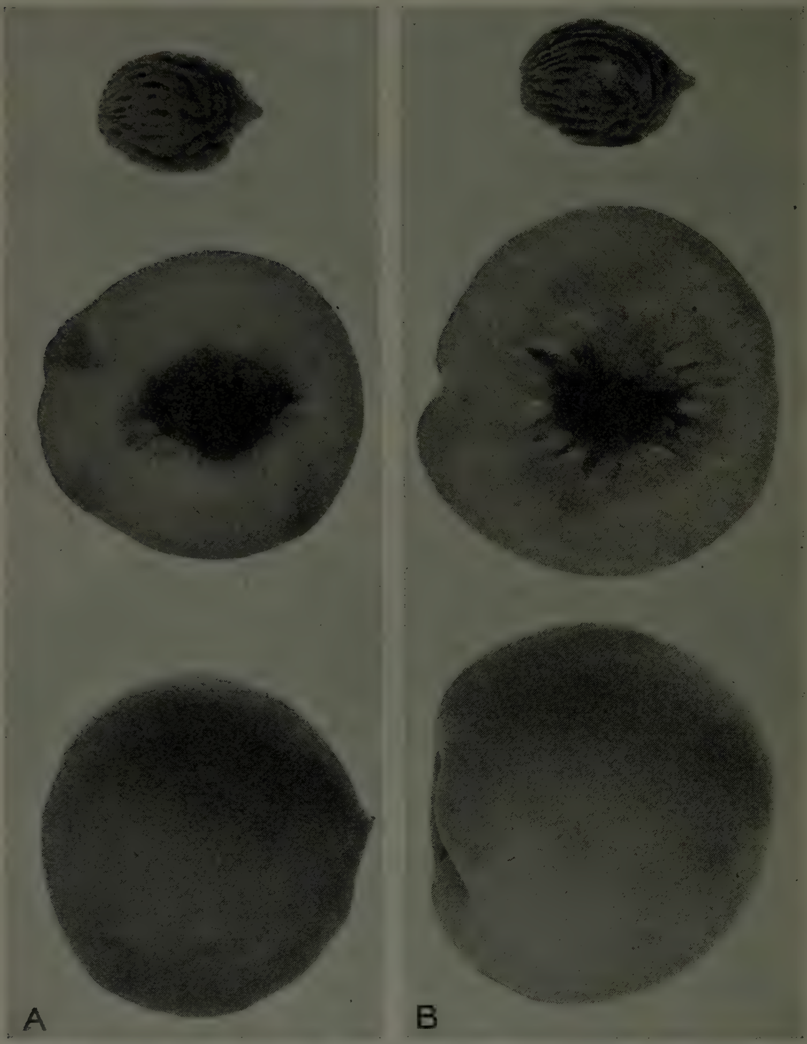


FIGURE 3.—A, Normal Sims peaches, still immature; B, mature Sims peaches that have ripened two weeks earlier than the normal (A), borne on a limb variation of the same tree. Merced, Calif.

Figure 4 shows a typical fruit from a desirable peach limb variation and one from an undesirable limb variation on another tree of the same variety. Progeny tests have proved both to be true variations.

Of the bud variations found in deciduous fruits, those occurring as limbs and known as " limb variations " have been most conspicuous. Individual-tree studies in an extensive orchard in central California, planted largely to a few established canning-peach varieties, have revealed 39 striking peach limb variations with the following outstanding characteristics: Fruits ripening earlier or later than those on the normal part of the tree (fig. 5); abnormal size, shape, color, or texture of fruits; abnormal size, shape, or quantity of leaves (fig. 6); and abnormal forms of vegetative growth. Progeny propagations have perpetuated the late-ripening character of the limb variation shown in Figure 5 and the abnormal leaves of the one shown in Figure 6. Such conspicuous variation from the normal had passed unnoticed because of unfamiliarity with the characteristics and significance of limb variations, and lack of knowledge as to when, where, and how to look for them. For the same reasons equally apparent limb variations have not been noticed more frequently in other deciduous orchards.

In the Wenatchee, Wash., district where several bud variations of the standard apple varieties are being grown commercially to an increasing extent, over 50 such variations are now under observation and test. Many other bud variations of apple varieties have been discovered and are being tested or grown commercially in Michigan, Massachusetts, New Jersey, New York, Virginia, and, in fact, in most of the important apple-producing sections. Growers, orchard workers, and others interested in apple growing are becoming familiar with the occurrence of bud variations showing differences in color, size, and other characters and are constantly on the alert during the fruiting season to discover new ones that may be of commercial value after being isolated and propagated as improved strains.

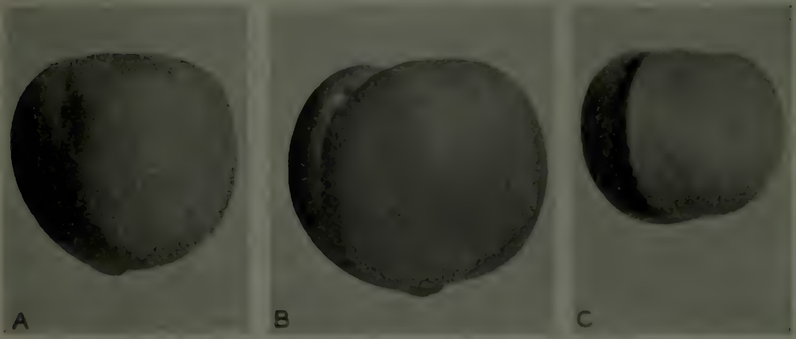


FIGURE 4.—Fruits from Ontario peach trees: A, Normal fruit; B, fruit borne on a limb variation, on same tree as A, that is apparently identical with that of the Peak variety; C, fruit with a deep red keel instead of the normal suture, from a limb variation in another tree. West Riverside and Ontario, Calif.

In a number of limb variations in peach, prune, and apricot trees the shape, size, and number of leaves are very different from those of the normal foliage borne by other limbs of the same tree. Limbs of peach, apricot, pear, and prune trees that bore variegated leaves or leaves with light-colored areas, have also been discovered and some have been propagated through buddings. They are of scientific interest and of possible commercial importance.

SEARCHING FOR BUD VARIATIONS

Early-maturing limb variations are most apparent two or three weeks before the normal fruits ripen, and when the color indicating maturity of the early fruits is in sharp contrast to the green of the immature, normal fruits. Such limbs or trees should be marked, their location in the orchard, the date of discovery, the apparent difference between the time of maturity of the fruits borne by the variation and that of the normal fruits, and any other descriptive matter should be recorded.

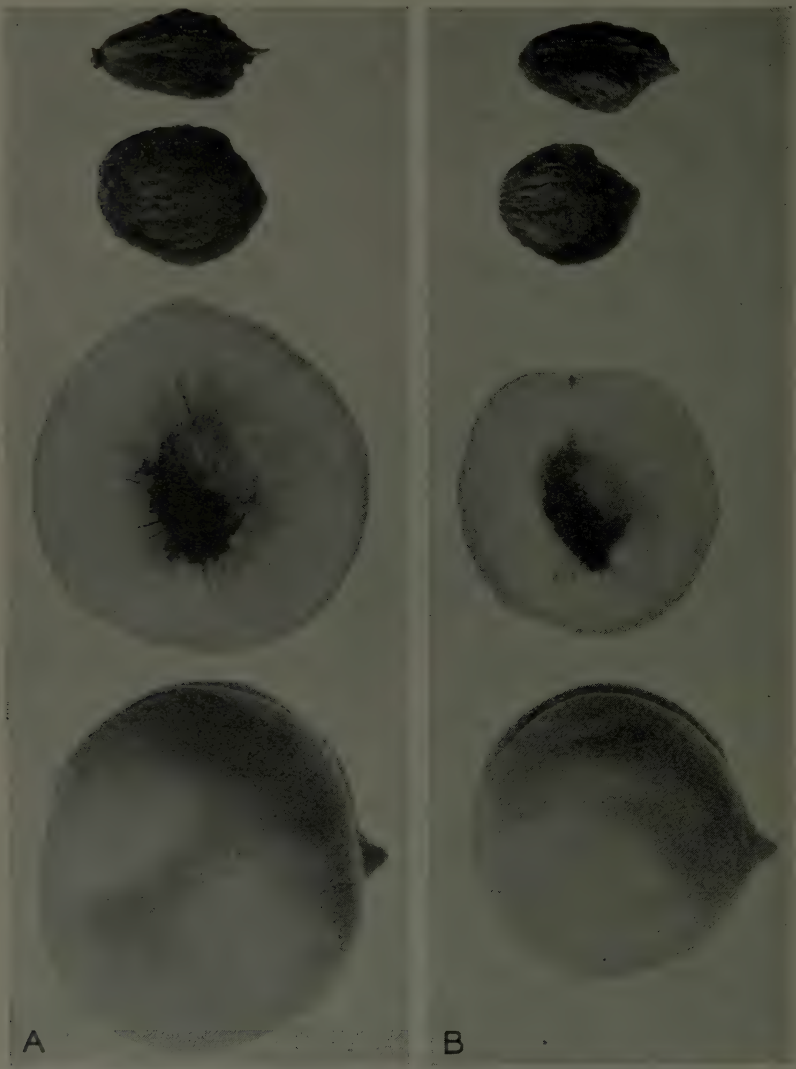


FIGURE 5.—A, Mature, normal fruits and seeds from Phillips Cling peach tree; B, immature fruits and seeds from a limb variation of the same tree. Merced, Calif.

Late-maturing limbs, entire trees, or individual fruits that are noticed at the normal time of harvest of the crop should be marked, their location recorded, and their characteristics described. The writers found several striking late-ripening limb variations by inspecting peach trees after the main crop had been picked.

Russeted-pear and other deciduous-fruit limb variations are most apparent when the fruits are approaching maturity. Large-fruited Bartlett pear and Winesap apple limb variations and others showing abnormal size or shape of fruits or peel texture are most apparent about the time the fruits are fully mature and just before harvest. In Figure 7 are shown russeted, corrugated, and other abnormal pears produced on limb variations.

Figure 8 shows a large-fruited Agen (French) prune from a limb variation similar to one from which a new variety originated.

The quantity of fruit per tree is, of course, observable over a considerable period, but is best studied about the time of harvest. The commercial qualities of the fruits are most conveniently studied just before or during harvest. However, the search for sporting limbs in otherwise normal fruiting trees or for entire tree variations is, on the whole, most efficient during a period of from two to three weeks before the actual harvest is begun.

FIGURE 6.—Lovell peach tree with a limb variation (left) having long, very narrow, glandless leaves. Merced, Calif.

OBTAINING INDIVIDUAL-TREE RECORDS

The work of obtaining individual-tree records is much simpler if carefully planned before the harvest. Experience has shown that in some instances it is best for the grower to study only a small block of trees in the beginning in order that he may become familiar with the methods of study. An increasing number of trees may be observed during later years.

INDIVIDUAL-TREE NUMBERS

In order to identify any considerable number of individual trees with certainty, year after year, some method of numbering and marking them is necessary. Such a plan assigns to each tree a combination number consisting of the number of the orchard block or section, the number of the tree row in the block, and the number of

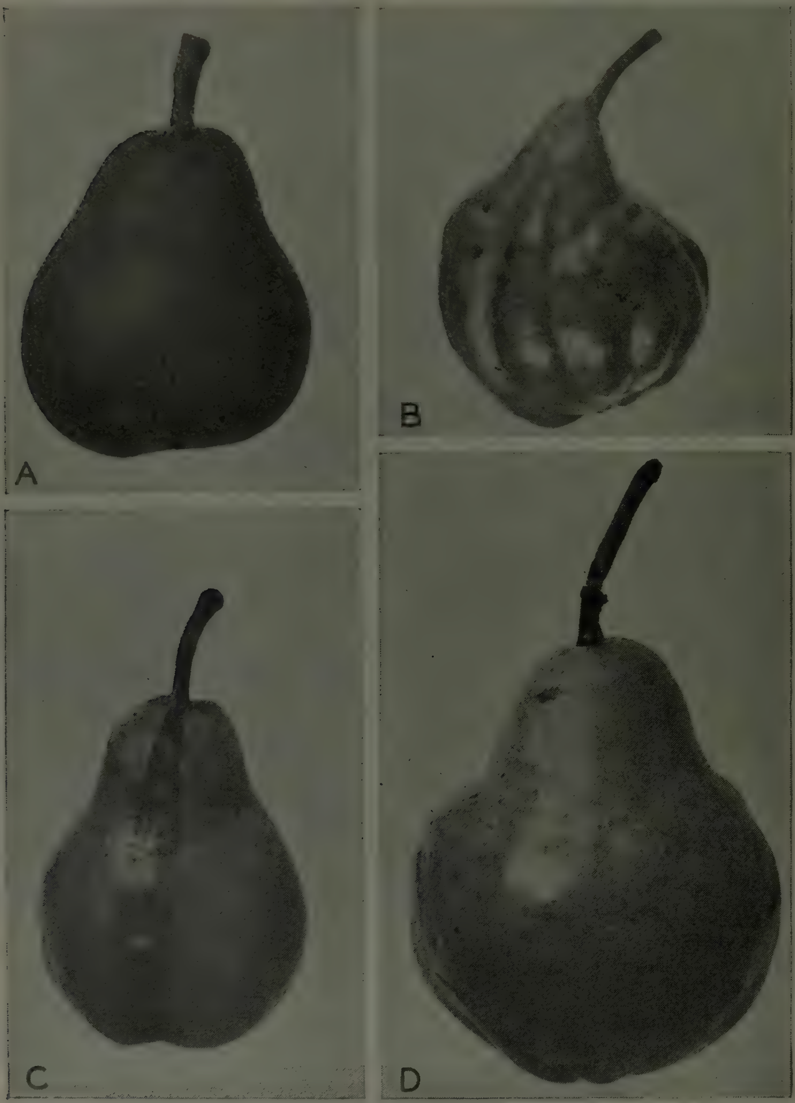


FIGURE 7.—Fruits from limb variations in a 40-year-old orchard of Bartlett pears: A, Heavily russeted; B, corrugated; C, russeted section; D, collared. Santa Clara, Calif.

the tree in the row, always counting from some fixed point. For example, the number of tree 20 in row 18 of orchard block 14 will be 14–18–20. In small orchards the individual-tree number may include only the tree and row numbers.

The numbers may be painted in vertical columns on the trunks of the larger trees, as shown in Figure 9. The trunks should be brushed before the figures are painted, and the figures should be on the same side of all trunks in order to be found conveniently. Pure white-lead paint, applied with a lettering brush, is used. The numbers must be clear and large enough to be easily read from several feet away. After a little experience a workman, under ordinary conditions, can paint numbers on 175 trees a day. He should have a list of the numbers for each row and his work should be inspected frequently for correctness.

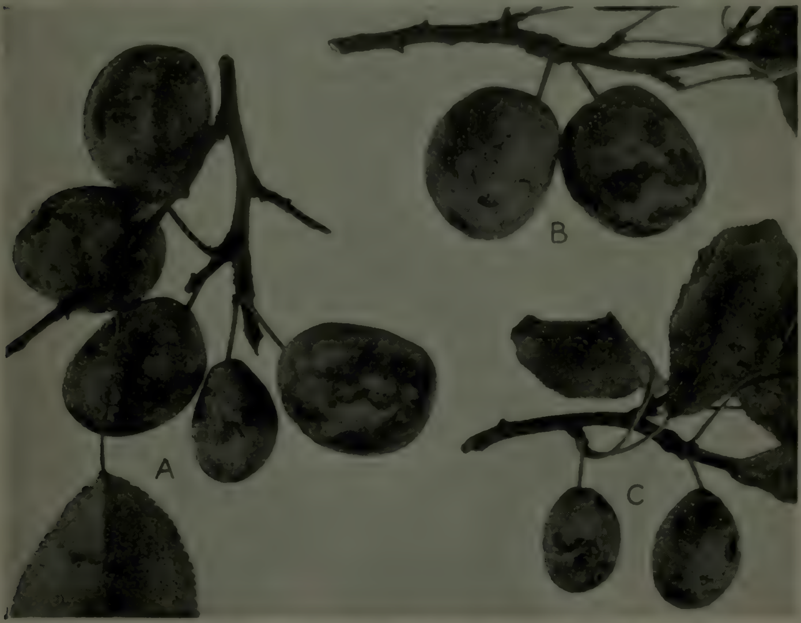


FIGURE 8.—Variations from a single Agen (French) prune tree: A, Bud variations; B, large-fruited limb variation similar to that from which a superior strain of fruit has been established by selection and propagation; C, normal fruit. Morgan Hill, Calif.

On very young trees with trunks so small that it is impracticable to paint the figures on them, the numbers are often printed on wooden labels or stamped on metal tags, which are so attached to the trees as not to interfere with their growth. Numbers on slightly larger trees, with trunks too small for the usual arrangement are sometimes arranged in a vertical column, one digit below another, the orchard block and the row and individual-tree figures being separated by horizontal lines. If the trunks are whitewashed or otherwise coated it will be necessary either to protect the figures or to use the labels suggested for very small trees.

If it is impracticable to paint tree numbers on all trees, the first and last and the fifth or tenth tree in each row may be numbered, but this is only slightly less expensive than painting numbers on all trees. The figures may become slightly distorted with the growth of the trunks, but they will ordinarily remain legible for several years, long enough for obtaining adequate data on individual-tree performances.

A map of the orchard, showing the tree numbers in the same relative positions as the trees in the planting, should be made to provide a permanent record of the arrangement and number of the trees.

RECORD FORMS

A printed loose-leaf form is useful for recording the performance data, though the grower may rule an ordinary notebook for this purpose. The form used by the writers is shown in Form A. It is printed on sheets 4 by 6 inches in size.

FORM A.—*Form for recording individual-tree performances in a field notebook*

LOCATION .... BLOCK ....
VARIETY .... ORCHARD .... ROW ....

Tree No.	Fruit				Tree			Notes
	Crop		Size	Ripe	Size	Type	Glands[1]	
	Quantity	Per cent						

RECORDS BY .... DATE ....

[1] The column marked "glands" is useful only on forms for records on peach trees.

The following definitions and directions are printed inside the front cover of the notebook used by the writers:

EXPLANATIONS OF TERMS AND SYMBOLS

TREE NO.—Record the tree numbers in use by the grower wherever possible; otherwise, explain in detail the system adopted and illustrate it with a diagram showing the arrangement of the orchard block and the method of numbering.

FRUIT:

Crop.—Record in the first column the estimated crop in number of boxes, pounds, or fruits, and indicate the unit used. In the second column record the estimated percentage of a maximum crop, taking into account the size and condition of the tree.

Size.—L=large size for the variety, S=small. Normal size need not be recorded.

Ripe.—Refers to the time of ripening as compared with the normal for the variety. E=early, L=late. Normal ripening need not be recorded.

TREE:

Size.—Refers to comparative size of trees in the block being studied. L=large, S=small. Normal size need not be recorded.

Type.—P=productive, P*=outstandingly productive, U=unproductive. Normal production need not be recorded.

GLANDS.—For use in peach variety studies. O=glandless, G=globose, R=reniform.

NOTES.—Record briefly any characteristic or condition of tree or fruit which may help explain the performance of the individual tree, such as disease, insect injury, broken limbs, striking variations of foliage or fruit, cultural treatment, pruning, replants, top-worked trees, or other phases of tree development.

FIELD RECORDS

Fruit from each tree may be picked and actually weighed, counted, or measured, or it may be estimated in terms of weight, number of fruits, number of containers, or the percentage of a theoretically full crop with age, size, and habit of growth of the tree taken into account. Factors such as kind of fruit, number and frequency of pickings, length of picking season, and availability of trained labor and supervision will determine whether the yield is actually measured or estimated. Actual measurement is desirable in experimental studies, but careful estimates are satisfactory for commercial orchardists.

Notes on abnormal blossoming dates, peculiar bloom characteristics, pruning, thinning, spraying, frost or wind injuries, and other tree conditions are helpful in interpreting results and may be kept in the field notebooks.

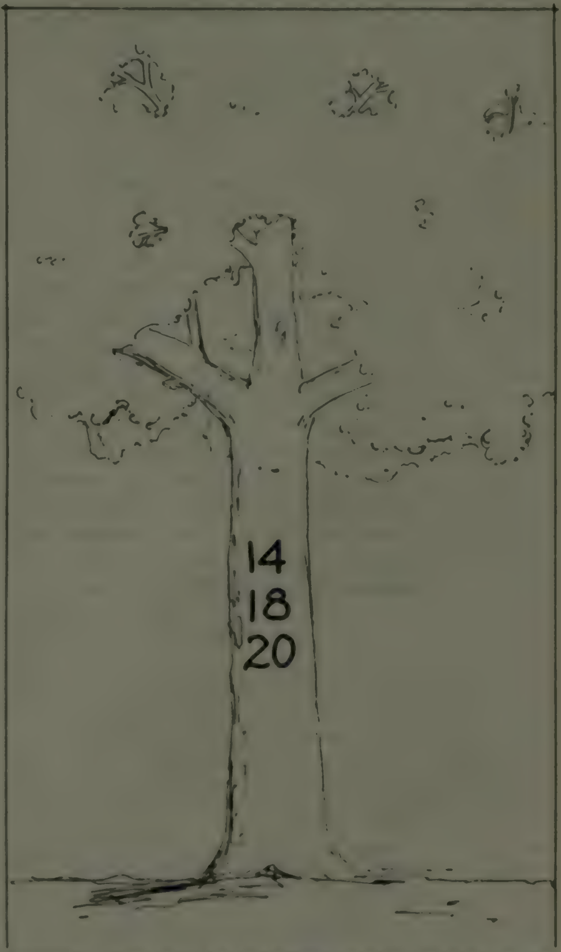


FIGURE 9.—Tree with its individual number painted on the trunk

Pickers and other employees, if told what to look for and how to look for it, can give valuable aid in discovering desirable bud variations by noticing striking foliage or fruit differences.

To obtain actual-yield records it is necessary to pick each tree separately and to record the quantity of fruit harvested from each tree at each picking. With the proper distribution of boxes and with trained labor, one recorder can keep up with a large number of pickers and can also record any unusual fruit or tree condition.

If the yield is recorded in terms of boxes or other fruit containers, a few filled containers should be weighed so that the records can be translated into terms of weight if desired. Partly filled containers should be weighed or the quantity of fruit in each estimated. Ordinarily, estimates to quarters of the recorded unit are sufficiently accurate.

For records of actual yields in some commercial orchards growers securely tie a strong paper tag about 3 by 6 inches to a branch on the same side and at about the same height on each tree. A form is usually printed on the tags with spaces for the name or number of the orchard, the individual-tree number, and for yields at several pickings. After each picking the yields should be copied from the tags into a notebook to prevent losing any of the data.

Persons not trained in estimating the yields of fruit trees should, at first, frequently check their estimates with actual picking records.

Yield records are of increasing value when the work is carried on for several consecutive seasons, and it is desirable to have the same person make the estimate for each block of trees each year. The estimated quantity of fruit, and, if desired, the percentage of a full crop should be recorded, and notes made of any outstanding or abnormal characteristics, such as the size and degree of ripeness of the fruits and the size, type of growth, and other characteristics of the trees. To avoid unnecessary note making, only conditions and characteristics markedly different from the normal are recorded.

The tree-estimate records should be obtained shortly before the fruits are picked. At this time it is possible to judge the size, color, and shape of fruits, as well as the approximate quantity. Some satisfactory estimate records have been made a week or 10 days before picking, but, as a rule, these data have been obtained 2 or 3 days before the commercial harvest.

PERFORMANCE-RECORD PERIODS

Performance records covering the early years of full bearing are considered most valuable in locating undesirable trees. Undesirable trees can be top-worked or replanted with a minimum loss of time and with the least expense in early years.

To guide the selection of good-type trees as sources of bud wood for propagation, records for two consecutive years of normal full bearing are usually sufficient, but records covering four years are preferable. In comparing the results of cultural practices, the length of the performance-record period may be adapted to the individual conditions, in order to obtain adequate and reliable data. The ideal performance-record period covers the productive life of the trees.

ASSEMBLING DATA FROM FIELD RECORDS

The data from the field notebooks may be transferred to office forms, preferably loose-leaf type, on which the records for each tree for a period of years are brought together. The office form used by the writers is shown in Form B.[1]

---

[1] For economy of space, Form B as here reproduced is somewhat abridged as to number of trees. In actual use the form occupies a full sheet 8 by 10½ inches and allows space for records of four trees (instead of one) for eight years each.

FORM B.—*Loose-leaf form for assembling individual-tree performance records for a series of years*

TREE-PERFORMANCE RECORDS

LOCATION .... GROWER .... BLOCK ....
VARIETY .... ORCHARD .... ROW ....

Tree No.	Year	Fruit				Tree			Notes
		Crop		Size	Ripe	Size	Type	Glands	
		Quantity	Per cent						

In order to interpret the tree records intelligently it is desirable to assemble them in tables or charts on which the yearly crops and the total yields for the performance-record period can easily be compared and crop variations studied in connection with the relative positions of the trees in the orchards. Charts showing the distribution of trees with comparatively high, average, or low yields are helpful. An annual distribution chart will be interesting and instructive to the grower, but a chart showing the distribution of the average yields for a period of several seasons will indicate the relative values of the different trees.

A simple method of thus comparing individual-tree yields is illustrated in Table 1, which shows the estimated individual-tree yields in a block of Lovell peaches, expressed as percentages of a full crop for 1926. These trees were seriously affected by abnormal weather conditions during the preceding winter. On the south side of the block is a high windbreak. Relatively high yields from trees just north of the windbreak are shown in Table 1. They indicate that production in this part of the block was increased by the protection of the windbreak. Further investigation indicated that this protection consisted largely of shading the trees from the sun during hot days in the winter.

Recording the percentage of a full crop, as well as the actual yield, has the advantage of showing the production of the trees irrespective of their age and size, and without referring to other records. For instance, when charted on the basis of actual yield, a young tree in an older orchard would show a small crop among heavier yields and would thus appear to be a poor tree, whereas if the yields were shown as percentages of a full crop the normal young tree would be indicated as comparable to the older ones. The method of charting any particular orchard will depend largely upon the purpose of the record.

TABLE 1.—*Individual-tree production for 1926 in 10 rows of a block of Lovell peaches, Cucamonga, Calif., expressed as percentages of a full crop*

[Each figure indicates the percentage of a full crop borne by one tree. Beyond tree 24 of each row this orchard was bordered by a double-row planting of tall Eucalyptus trees]

Tree No.	Row No.—										
	50	51	52	53	54	55	56	57	58	59	
1	½	1	0	0	1	0	½	0	2	1	
2	2	1	0	0	2	1	0	0	2	4	
3	¼	1	0	2	R.	0	2	1	½	3	
4	1	4	0	0	2	1	3	1	1	5	
5	4	20	4	5	1	½	5	1	2	1	N
6	1	1	1	10	4	8	2	2	3	3	
7	2	1	3	5	8	1	0	2	1	½	↑
8	1	10	0	0	4	1	R.	0	4	3	
9	1	8	2	3	D.	6	0	0	2	1	
10	2	1	3	10	8	S.	1	0	1	3	
11	2	5	3	4	—	3	0	4	4	8	
12	1	15	2	2	½	1	2	2	0	2	
13	6	40	1	3	1.	3	2	2	1	5	
14	1	3	12	5	1	12	1	1	8	4	
15	1	4	0	0	5	2	0	2	2	2	
16	3	5	3	5	2	4	0	2	5	3	
17	4	R.	2	10	1	6	1	10	10	5	
18	20	30	10	1	15	5	5	5	15	30	
19	25	35	10	2	20	25	10	20	15	25	
20	60	50	25	40	40	35	30	R.	30	30	
21	75	90	66	66	75	80	66	75	75	80	
22	80	75	75	75	85	90	66	66	60	75	
23	90	85	66	60	90	85	40	85	70	60	
24	50	75	—	—	25	75	—	—	—	50	

0 indicates no crop.
R. indicates a replanted tree.
S. indicates a seedling tree.
D. indicates a diseased tree.
— indicates no tree.

One plan of charting individual-tree performance records is to select different colors for trees with high, medium, and low yields, and to color the squares on the chart according to the amounts or percentages of yield shown by the trees in that square. Superior trees may be designated by some special symbol.

Different symbols may be used, like different colors, to indicate various classes of yields, and the appropriate symbols placed on the chart to mark the relative locations of the trees whose yields they indicate. Trees may be divided into classes according to whether they are unprofitable, barely pay for their maintenance, or are profitable. Superior trees suitable as sources of bud wood for propagation may be identified by special symbols on the chart, as may other trees that require replacing, top-working, or other care.

Actual yields may be recorded in figures on the chart at the relative positions of the trees to which the figures apply. Different colors of ink and different symbols can indicate diseased or injured trees, poor trees that are to be replaced or top-worked, and superior trees suitable as sources of bud wood.

USING INDIVIDUAL-TREE RECORDS

The data on individual-tree performances may be used (1) in locating superior strains for commercial use; (2) in locating unprofitable trees that need top-working or replanting; (3) in making progeny tests of selected parent trees; (4) as the basis for systematic care of individual trees; (5) in comparing the results of different cultural practices; and (6) in establishing reliable sources of propagating material.

ISOLATING AND PROPAGATING SUPERIOR STRAINS

In order to maintain the fruit-producing efficiency of an established fruit variety it is advisable to propagate the variety commercially with bud wood only from trees of good type. After such trees have been identified by their performance records they should be carefully studied in the orchard before the next crop is picked, and outstanding trees that by reason of their fruit and vegetative characteristics seem best suited for propagation should be selected. Through systematic selection of the best trees as sources of bud wood, further propagation of undesirable strains can be largely eliminated.

Striking limb or entire-tree variations should be carefully observed and their blossoming and fruiting characteristics systematically studied for two or three years. If they are found to be of possible commercial value, progeny propagations from them should be made in order to determine the performance of the progeny in the orchard, particularly its inherent stability. From the results of the experimental progeny tests, conclusions on the desirability of making commercial orchard tests of the promising variations can be drawn.

LOCATING UNPROFITABLE TREES

Trees that are healthy, yet shown by their performance records to be consistently low yielding and unprofitable, may be top-worked or replaced. Individual factors will determine which process to use. Top-worked trees should receive individual care for several years after the operation, to make sure that new growth develops solely from the bud wood and is so pruned as to develop strong and well-balanced tops. In replanting in mature orchards it is advisable to plow or dig ditches entirely around the young trees and fill the ditches with manure or other fertilizer to stimulate growth of the young trees and lessen competition with the larger root systems of older neighboring trees.

MAKING PROGENY TESTS OF SELECTED PARENT TREES

Progeny tests are recommended for obtaining definite evidence on the transmissibility of important tree characters discovered in the course of the individual-tree record work. These tests can be made either by top-working established trees or by budding nursery seedlings. Top-working gives quicker results than budding, but it is often impracticable to obtain satisfactory trees for top-working. Nursery budding, therefore, is ordinarily the more practical method.

In propagating selected parent trees, all bud sticks from each tree may be given the parent-tree number. If propagations are being made from a number of different orchards, the records can be simplified by establishing a new series of propagation numbers, and then making a key list showing the parent tree represented by each number on the new list, the date it was propagated, and other related information.

When the progeny trees begin production their individual-tree yields may be kept for a period of years in order to determine the inherent stability of the progenies and their relative value for commercial use. Only the best progeny trees should be chosen for further propagation.

In making progeny tests of striking limb variations, bud wood should be taken from the variation and from a normal branch of the same parent tree and numbered with distinctive modifications of the parent-tree numbers. If the parent tree number is 3–21–6, bud wood from the normal limb may be 3–21–6A and that from the limb sport 3–21–6B. More than one limb sport from the same parent tree may be identified by different letters. If many limb-sport propagations are to be made a new system of numbering the progeny may be adopted, as 1A and 1B, 2A and 2B, for normal and variable forms, respectively, from each tree, and a key list made describing the various characters of the propagations.

COMPARING CULTURAL PRACTICES

Tabulating individual-tree yields in an orchard block may reveal areas of light production caused by differences in soil types or earlier soil treatments. Plotting the yields of one orchard showed an area of low yields near the center of the block. The low yields were found to have been caused by the removal of the surface soil in grading for irrigation before the orchard was planted. These trees were brought up to normal production by resurfacing the area with top soil from outside the orchard. It was also found that low yields of trees near the irrigation flume and at the lower ends of the rows were caused by poor soil conditions and were improved by correcting these conditions.

Performance records will show definitely the behavior of trees that have been treated for disease or insect infestation and will indicate the proper ultimate disposal for them.

The death of trees often causes considerable loss, and in close plantings it is sometimes difficult to decide whether it is profitable to replant the vacant spaces. Individual-tree records make it possible to compare the production of trees near the vacant spaces with that of trees in solidly planted areas, and to determine the advisability of replanting.

It is sometimes wise to try out fertilizer treatments on small plots before adopting them for general orchard use. Individual-tree performance records are of great assistance in interpreting results of such tests.

The relation between production of individual trees and the length of the irrigation run can be ascertained from individual-tree records. Effects of different methods of pruning and different degrees of severity of pruning will also be shown by such data. The effects of different kinds of cultivation, of different varieties of cover crops, and of many other factors can also be compared through a study of performance-record data.

Abnormal limbs in otherwise normal trees sometimes reduce the production of the trees or add to the expense of sorting the fruit. Through individual-tree performance records such limbs can be found and their characteristics determined so that they can be pruned out if proved undesirable.

ESTABLISHING RELIABLE COMMERCIAL SOURCES OF PROPAGATING MATERIAL

In studies of citrus varieties systematic individual-tree performance records have been a practical and successful guide in selecting superior trees as sources of propagating material. Investigations in deciduous orchards from 1921 to 1931 indicate that similar records will give reliable guidance in propagating deciduous-fruit trees.

Study of individual-tree records as guides in bud selection includes: (1) A comparison of the quantity and quality of fruit produced over a period of years; (2) a study of the environment of any particular tree in relation to its productivity; and (3) careful observation of the relative uniformity of the type of fruits borne by the trees. As a result of these studies it should be possible to select those trees that have been the most consistent in producing high yields of uniformly good fruits. Other less definable considerations enter into the selection of superior parent trees, particularly the experience of intimate tree knowledge gained in securing and assembling the records. With such experience comes greater facility in studying variations and selecting superior individual trees.

Cooperative or other organizations of deciduous-fruit growers can aid individual orchardists by procuring and supplying selected buds. The success of deciduous-fruit industries depends in part upon the quantity per acre and the commercial quality of the fruit to be marketed, and propagating good-type trees of the different varieties is a fundamental factor, since the individual tree is the unit of production.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	ARTHUR M. HYDE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel and Business Administration.	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Solicitor	E. L. MARSHALL.
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Forest Service	R. Y. STUART, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Bureau of Plant Quarantine	LEE A. STRONG, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Weather Bureau	CHARLES F. MARVIN, *Chief.*

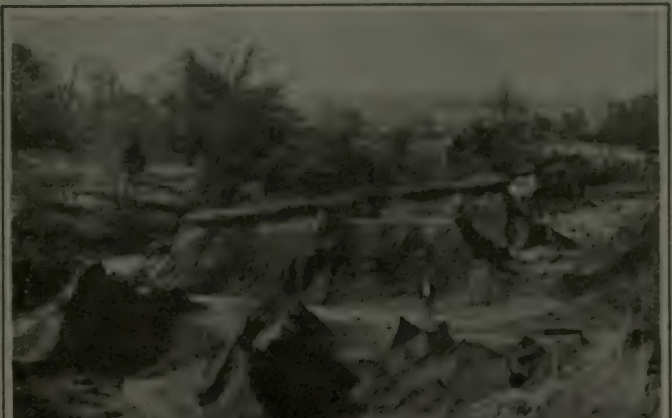
U. S. GOVERNMENT PRINTING OFFICE: 1933

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

Fred

U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1697

USING SOIL-BINDING PLANTS TO RECLAIM GULLIES IN THE SOUTH



MILLIONS OF ACRES on abandoned farm and other land are eroding at an appalling rate throughout the uplands of the South. This erosion not only causes financial loss to the landowners—it also menaces cultivated fields and other property.

Soil-binding vegetation, often employed in connection with small brush dams, affords a cheap and effective means of controlling the spread of large gullies and washes. Although, because of the unproductive soils exposed in gullies, relatively few plant species can be grown on such sites, certain trees, vines, and grasses have been successfully planted on eroded lands and have not only proved effective in reclaiming the soil but have produced returns in wood products or forage. This bulletin describes these species and recommends their use for gully reclamation.

Washington, D. C. Issued January, 1933

USING SOIL-BINDING PLANTS TO RECLAIM GULLIES IN THE SOUTH

By H. G. Meginnis, *Junior Forester, Southern Forest Experiment Station, Forest Service*

CONTENTS

	Page
Use of black locust and other trees	2
Use of vines and creeping plants	9
Use of grasses	14

GULLIES THAT have destroyed or are destroying the productive value of millions of acres of eroded and abandoned farm land in Southern States can be stopped and the land reclaimed by proper control measures. Planting natural soil binders such as trees, shrubs, vines, and grasses, which are at the same time agencies for building and restoring fertile soil, is one of these measures. It is cheaper than the construction of dams and dikes,[1] and the effectiveness of plants in obstructing rapid run-off, holding topsoil, and permitting rapid absorption of water can be seen wherever forests, brush, and grasses are growing.

Owners might at one time have prevented the beginning of such deep gullying as is pictured on the cover of this bulletin. By contour plowing, proper terracing, and the use of winter cover crops they could have checked, in its early stages, the washing away of the fertile topsoil from sloping lands. Once such land is abandoned, perhaps burned over repeatedly, or overgrazed, gullying is speeded up beyond the possibility of any such control. Owners are inclined to forget, not only that they are paying taxes on this waste land, but also that small gullies on abandoned fields can, within a few years, develop into huge washes that eat back into the uplands to encroach on areas still cultivated and to menace buildings and other property. Owners may overlook, too, the fact that outwash from such gullies may ruin alluvial farm lands by depositing on them a layer of infertile sand and gravel.

Gullies are not only an evil in themselves, but frequently a menace to all adjacent productive land, threatening losses likely to be far greater than the cost of prevention.

Most of the studies described in this publication were made on the silt loam uplands of the lower Mississippi Valley (fig. 1), but the results and conclusions obtained there are applicable in many portions of the South where conditions are similar. The first problem has been to determine just what type of vegetation is most effective in holding the soil, particularly on severely eroded and gullied areas. On such areas most if not all of the fertile topsoil and part of the subsoil were washed away before the land was abandoned, and wherever erosion has progressed to any considerable extent, the infertile, underlying materials have been exposed. These are not true soils but rather sands, gravels, and thick, plastic clays that would require ages of weathering to become fertile. The difficulty is that, although vegetation often becomes established naturally in the smaller gullies, very few plants invade these unproductive surface materials in the larger washes.

---

[1] Information on engineering means of gully control is given in Farmers' Bulletin 1234, Gullies: How to Control and Reclaim Them. Further information on this general subject will be found in Department Circular 33, Soil Erosion a National Menace, and Leaflet 82, Controlling Small Gullies by Bluegrass Sod.

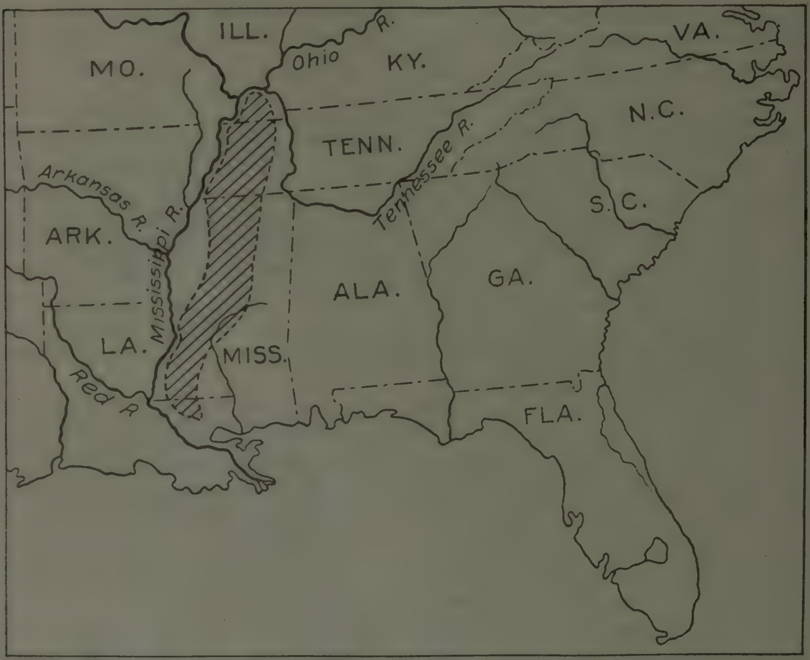
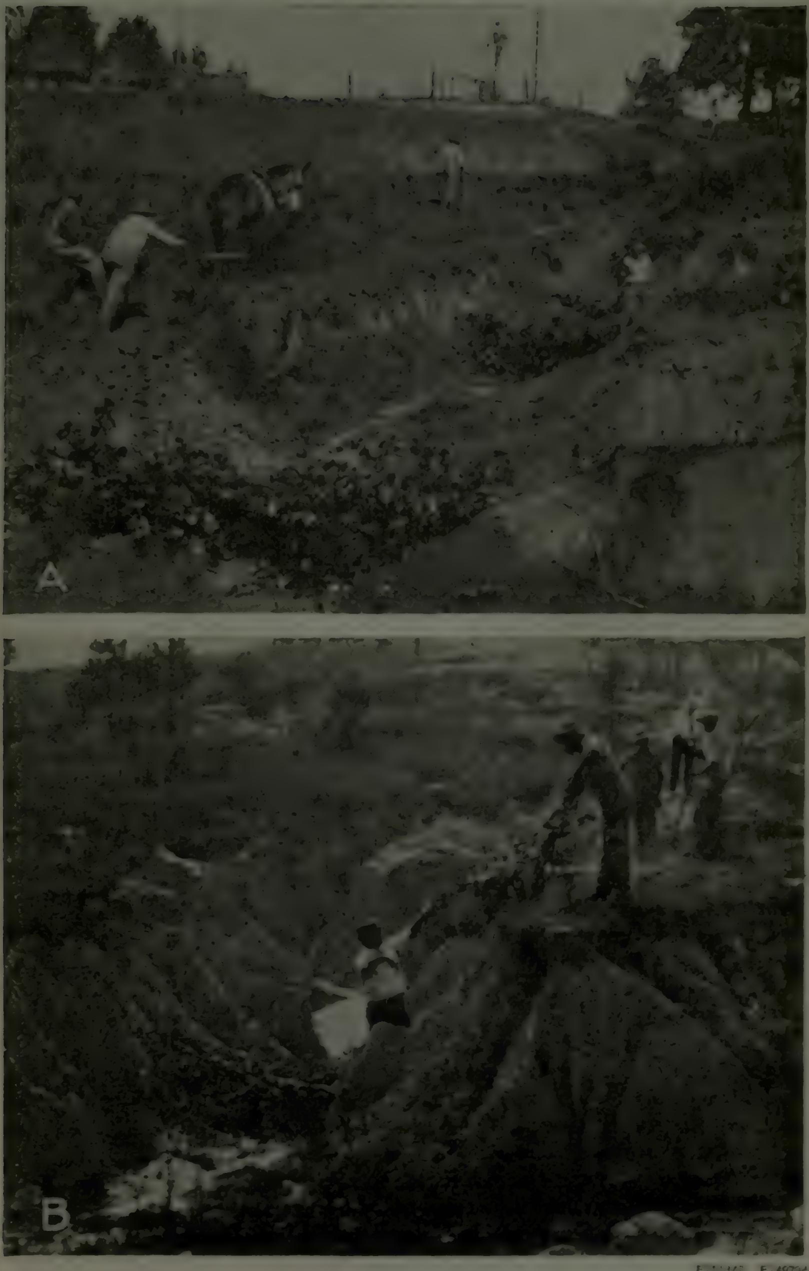


FIGURE 1.—The shaded portion of the map indicates the location of the loess bluffs and silt loam uplands where the studies here described were made

USE OF BLACK LOCUST AND OTHER TREES

One of the best and most widely used soil binders, in this area, is black locust (*Robinia pseudoacacia* L.). With its wide-spreading and interlacing root system this rapid-growing and valuable tree can halt erosion very effectively in a few years, even in such bad washes as that shown in the cover illustration. It is not only particularly well adapted for growth on most eroded sites and exposed clay subsoils much too poor for agricultural use, but, like most legumes, it also builds up the soil by contributing nitrogen. Many huge washes, some as deep as 30 feet and covering several acres, have been reclaimed by using this tree under the direction of the Tennessee



[illegible] F-49794

FIGURE 2.—Treatment given a gully preparatory to planting black locust or other vegetation: A, Plowing in the gully edges. Intervening areas between the gullies should also be deeply plowed. B, Constructing the proper type of dam

State Forest Service. Furthermore, excellent fence-post material can be cut from plantations 10 years or so old. If the posts are not desired, the locust can with good effect be cut back after the first year and a plow furrow run between the rows. This will cause the broken roots to sprout and form a dense thicket still more effective than the rows of trees in checking erosion.

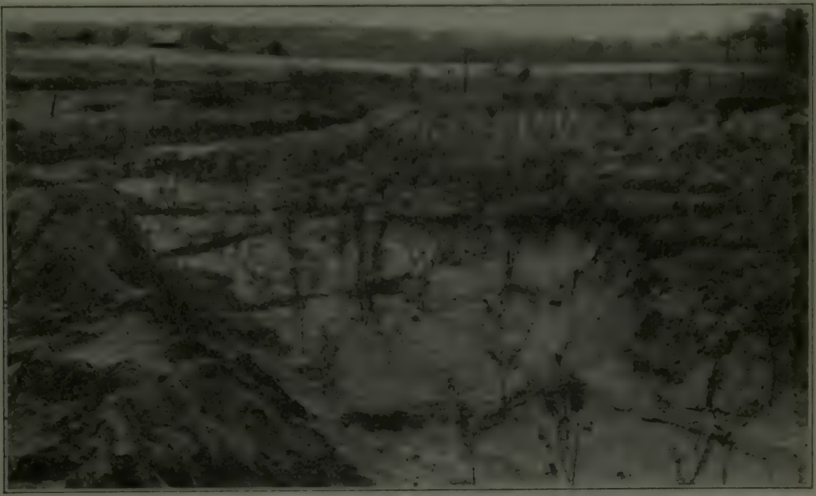
The method of establishing black locust on gullied lands can, with some slight modifications, be used with any other desirable tree species. Some preparatory work is necessary. In the early fall the edges of gully banks should be plowed in. (Fig. 2, A.) At the same time brush dams or barriers should be built about 12 to 24 inches high and near enough together so that the outwash held by any one dam will extend up the gully to the base of the dam immediately above. (Fig. 2 B.) Dams are constructed of bushes, limbs, or small trees laid compactly across the gully bottom and weighted down with logs, stones, or other heavy material. The ends of such brush barriers should extend well into the gully banks to prevent side cutting. The upper side should be thatched with straw, corn stover, pine tops, or similar material that will filter out and hold the soil, but the dams should not be made water-tight, since the purpose is to hold soil, not water.

By March or April such dams will have caught a great deal of the loose soil carried off by the winter rains. Much of the topsoil will also have been deposited over the less productive soils of the gully sides. In these deposits the thrifty 1-year-old black locust seedlings to be set out on the area can then be planted. (Fig. 3.) Nursery stock 18 inches high is best for this purpose. Larger seedlings will survive no better and will be more difficult to plant. Such stock can be bought for a few dollars a thousand, and 1,200 seedlings are sufficient to plant 1 acre of land. They should be set out 6 feet apart in evenly spaced rows. Where portions of the planting site are unstable or subject to later deposits of soil, regular spacing is less essential than planting the seedlings in the more favorable spots. The young trees should be protected from fire and grazing for several years and should be pruned during the second summer in order to increase growth and improve form.

Stands so established will often produce 1,000 or more posts on an acre within 10 or 12 years, the posts having a market value of 20 to 25 cents each. Since the total expense of growing 1,000 black locust posts, including planting costs, and investment in land and taxes at 6 per cent compound interest, need not exceed $50, profits from reclaimed gullies are possible.

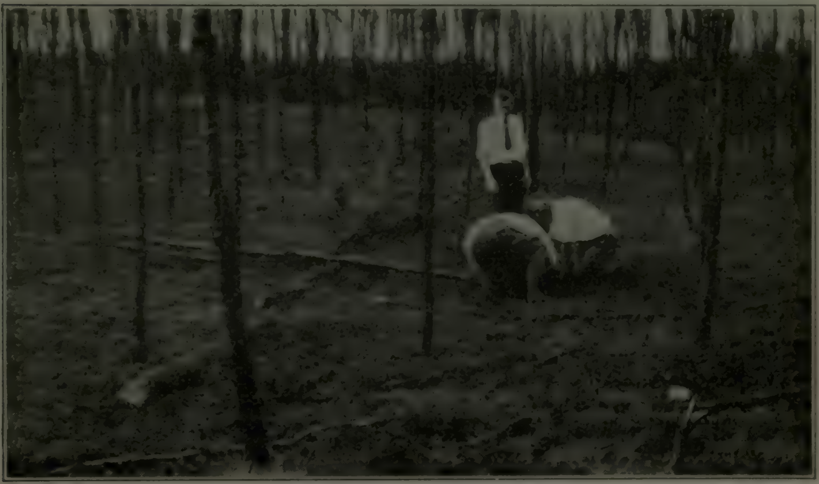
In gully-control work, however, the merits of black locust in reclaiming and enriching soil should receive first consideration, particularly on less productive sites where monetary returns from wood production may not be so satisfactory. A heavy sod of bluegrass (*Poa* sp.) and other palatable pasture grasses has repeatedly been observed in locust plantations on gullied lands formerly too impoverished to support any vegetation. (Fig. 4.)

Another tree species promising for planting gullied lands in the South is shortleaf pine (*Pinus echinata* Mill.). Though the species lacks the rapid growth and aggressively spreading root system of black locust, it grows better on pure sands. Shortleaf pine, like



F.4[illegible]18

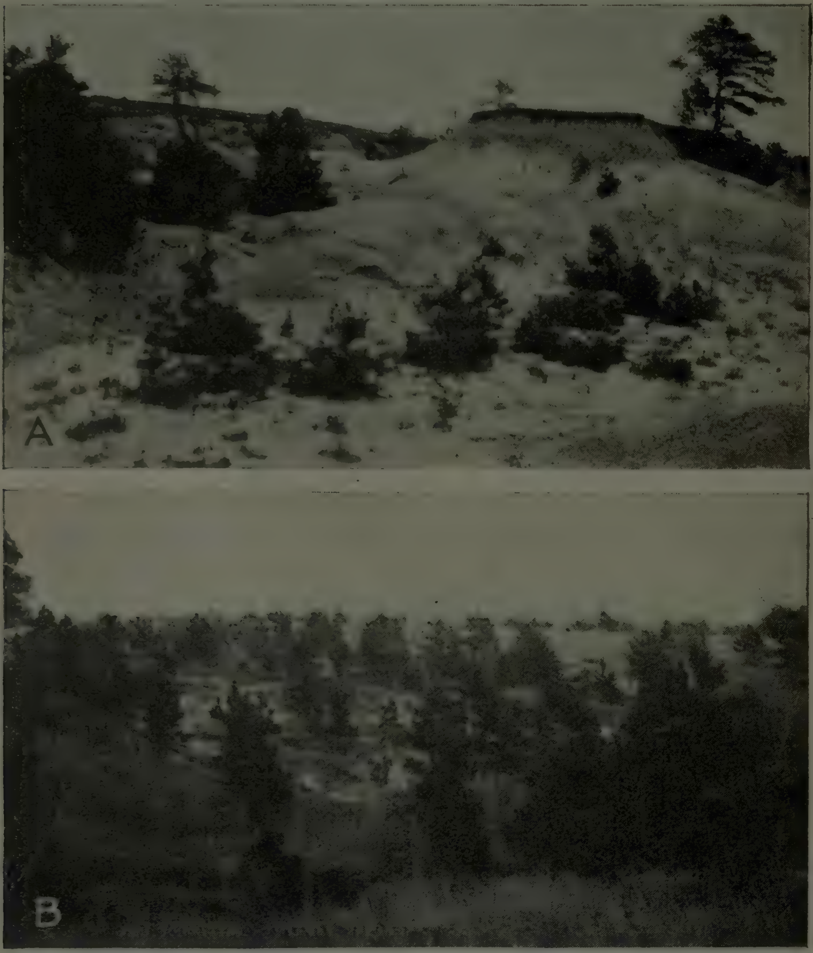
FIGURE 3.—Large wash on a western Tennessee farm, similar to that shown on cover, one year after the construction of brush dams and the planting of black locust. The dams have been almost entirely covered with soil outwash. Given proper protection, this gully will in a few years be as completely reclaimed as that shown in Figure 4



F245122

FIGURE 4.—This 10-year-old black locust plantation has completely reclaimed the once-eroded waste. The original wash, the contours of which can still be seen, was entirely barren. Note present crop of thrifty black locust trees of fence-post size and the ground cover of pasture grasses

black locust, is especially able to grow on inferior, depleted soils. (Fig. 5, A.) On badly denuded washes on which only the most sterile subsoils are exposed, shortleaf pine seedlings are frequently the only native vegetation. In the territory within the natural range of the species, examples of how it has controlled erosion can be seen in practically every abandoned field where shortleaf pine has become established in the gullies. (Fig. 5, B.) The manner in which shortleaf pine seedlings come in on the rapidly eroding surfaces of the larger washes and cling tenaciously to the unstable soils indicates that this species should find wide use in erosion control.



F247058 F239632

FIGURE 5.—Gullied land being reclaimed by shortleaf pine: A, Shortleaf pine seedlings coming in on an eroded clay too poor to support most other vegetation. Although giving evidence of having been injured by fires, the young pines are growing more vigorously than the stunted grasses. B, Shortleaf pine reproduction becoming established in the gullies of an abandoned field

When shortleaf pine is planted in a large wash, the trees can be planted in pure stands on the more sandy exposures or in alternate rows with black locust on the loams and clays. Nothing but the best nursery-grown stock should be used. Short, stocky seedlings with vigorous, well-developed roots will not only have a higher percentage of survival but will grow more rapidly than the tall spindling seedlings commonly produced in overcrowded nursery beds. One-year-old seedlings of shortleaf pine can usually be purchased from commercial nurseries for about $2 per thousand. Before being planted the long straggling tips of the roots should be cut off (fig. 6), since this will facilitate planting and will result in better subsequent root growth.

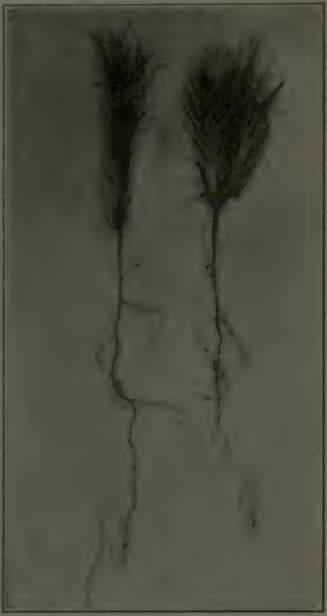

F211434

FIGURE 6.—One-year-old nursery seedlings of shortleaf pine suitable for gully-control planting. The long straggling roots should be pruned before being planted. One-inch squares in background

In the South the standard practice of planting pine seedlings consists of (1) making a hole or slit in the ground with a dibble, planting bar, or spade; (2) placing the seedling in the cavity thus made at the same depth at which it grew in the nursery bed; and (3) closing the slit by thrusting the planting tool into the soil several inches behind the opening and forcing the soil around the tree. During planting operations great care should be taken to keep the roots of the seedlings moist. Pine seedlings can easily be killed by exposure of the roots to the drying effects of wind and sunlight for only a few minutes.

In addition to its use as a gully reclaimer, shortleaf pine is a valuable timber tree. Although owners in the past have considered second-growth pines as weeds to be kept from field and pasture, such trees have actually added to the operating life of many southern sawmills. There is at least a possibility that this tree will become increasingly valuable as the paper industry and other industrial uses develop. Planting shortleaf pine seedlings on unproductive, eroded soils might give only a slow rate of growth during the years of establishment, but observations indicate that their growth rate in deep gullies does not differ appreciably from that on adjacent uneroded soils. Even on gullied areas, shortleaf pine can be grown to merchantable saw-log size in 35 to 40 years.

Loblolly pine (*Pinus taeda* L.) is another southern pine that may be used for gully control, although it is somewhat more exacting in its site requirements than shortleaf pine and has a more restricted natural range. Loblolly pine seeds in abundantly on gullied and abandoned fields in that portion of the silt loam uplands lying south of central Mississippi, and it is in this region that the species should prove most useful for controlling erosion. Loblolly pine will seldom do as well as shortleaf pine on extremely dry sands, outcrops of gravel, or heavy, impervious clays, but because of its more rapid rate of growth and the greater amount of needles that fall from it, it should be favored for less deeply cut gullies or washes which have not cut completely through the deposits of silt loam or loess. The exposure of sands and other coastal-plain strata in large gullies does not preclude the planting of loblolly pine on such sites if the soil materials are not too much depleted and if they contain ample supplies of moisture. Preparation of the gully before planting is even more important for loblolly than for the other species.

When rain has been plentiful cottonwood (*Populus deltoides virginiana* (Castigl.) Sudw.) and various willows (*Salix* spp.) are easily propagated by planting cuttings from the present or previous year's growth, and these serve admirably in several ways to check the growth of gullies. Closely spaced rows of cottonwood cuttings planted in gullies at right angles to the direction of flow will often catch a surprising quantity of soil. (Fig. 7.) Ordinary brush dams can be effectively anchored by pegging down the brush with stakes made from green limbs of cottonwood or willow. As these develop roots the brush will be the more securely anchored. The sprouts that follow will be able to withstand considerable burying by outwash and will tend to increase the effective height of the dam.

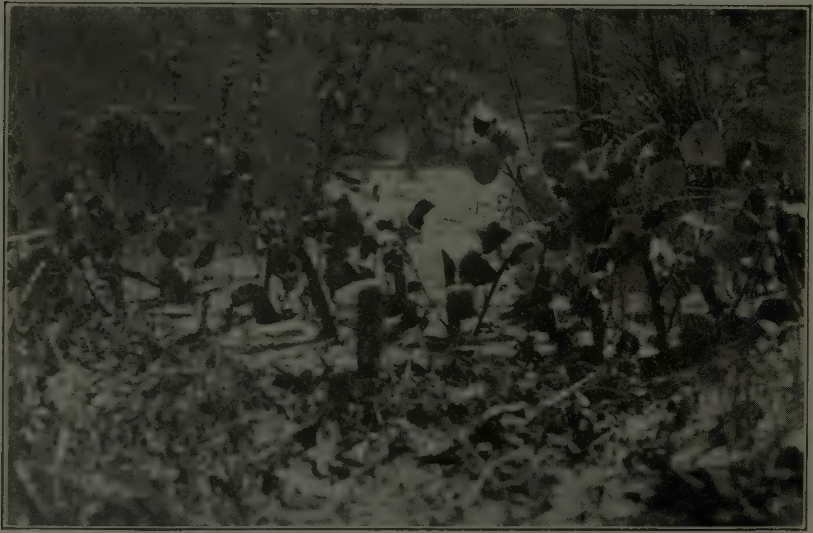

F258532

FIGURE 7.—Cottonwood cuttings planted across a gully bottom. Soil and other eroded material has already been caught and deposited

The size of the cuttings planted is not particularly important, but the most convenient size is 10 to 12 inches long and one-half to three-quarters inch in diameter. Cuttings should be made after growth ceases in the late fall and should be stored in a cool, moist place until the following spring. Burying the cuttings below the frost line in sand or any other well-drained soil is the usual storage practice.

The seeding in of trees in the gully bottoms is also helpful. Full dependence can not be placed on this process to restore the land to a productive condition, but such seeding in, in conjunction with the use of brush dams and other soil-catching devices, is a preliminary measure to be followed by other steps in restoring the land to productivity. During the spring germination period, cottonwood and willows frequently seed in, in this way, on the loose sands of gully bottoms that contain sufficient moisture. Once established, these moisture-requiring species will often grow readily on what appear to be very arid sands, because of the ability of their roots to maintain contact with the water table.

Other less important tree species which seed in naturally on eroded areas are persimmon (*Diospyros virginiana* L.), sassafras (*Sassafras variifolium* (Salisb.) Ktze.), eastern red cedar (*Juniperus virginiana* L.), red gum (*Luiquidambar styraciflua* L.), sycamore (*Platanus occidentalis* L.), southern red oak (*Quercus rubra* L.), and Chickasaw plum (*Prunus angustifolia* Marsh.). With the exception of Chickasaw plum, which develops root suckers, thus forming dense thickets, these species are not especially efficient in stopping soil wash but because of their adaptability to the site may prove useful when planted in combination with other vegetation.

USE OF VINES AND CREEPING PLANTS

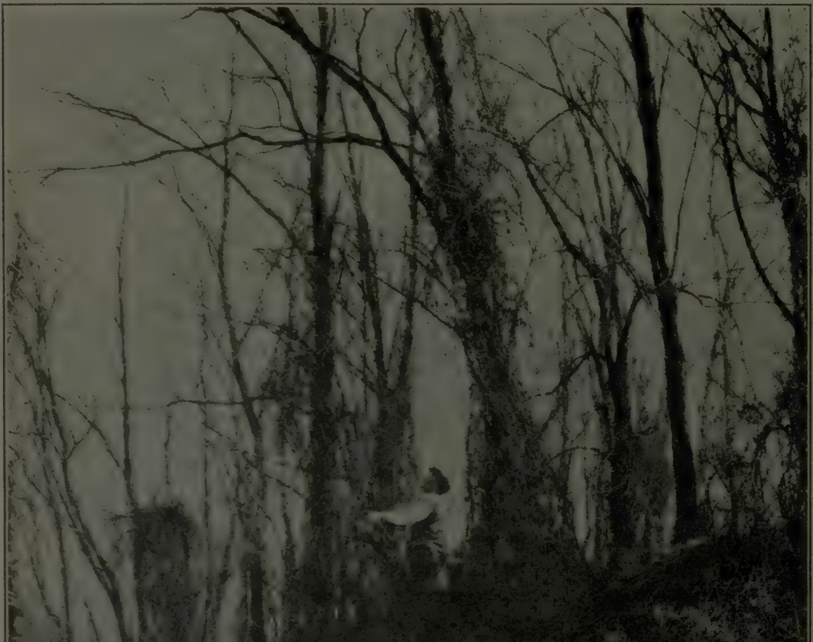
Vines and creeping plants, because of their habit of growth and the protective mass of vegetation with which they mantle an eroding surface, are especially valuable as a temporary means of stopping erosion. They are of questionable value, however, when used in combination with tree plantings, since it is almost impossible to grow trees to any size if vines are present. The weight of the vines in the branches of the trees is often enough to break out the tops and destroy the timber value of the stand.

Of the several kinds of vines that have proved effective in gully-control work, Japanese honeysuckle (*Lonicera japonica*) is perhaps best known. Although not a native species, this shrubby vine has escaped from cultivation and has become established throughout the loessial region of Mississippi and Tennessee and in other parts of the South. The plant is usually seen covering the sides of road cuts and filling large washes with a dense mat of vines. For some reason it prefers the society of black locust, and wherever black locust occurs naturally Japanese honeysuckle is now nearly always associated with it. In several instances in northern Mississippi this honeysuckle has been planted with black locust in large gullies and has completely stopped soil washing. (Fig. 8.) The common method of propagation is to plant rooted portions of the stem. These grow readily and soon produce a cover.

Perhaps the most promising soil-binding vine for gully control is kudzu (*Pueraria thunbergiana*), a species of legume introduced from China and much planted in this country as an ornamental.[2] This vine occasionally makes a phenomenal growth on loose sands as well as on the heavier clays and loams. (Fig. 9, A.) The vines show a tendency to clamber over trees, tall grass, and other vegetation where these occupy the site. When kudzu is established on barren, eroded soils, however, the vines cling closely to the ground, root deeply at the nodes, growing customarily 25 to 50 feet in a single season. As a legume, kudzu, in addition to enriching the soil, provides large quantities of forage which is eaten avidly by livestock.

---

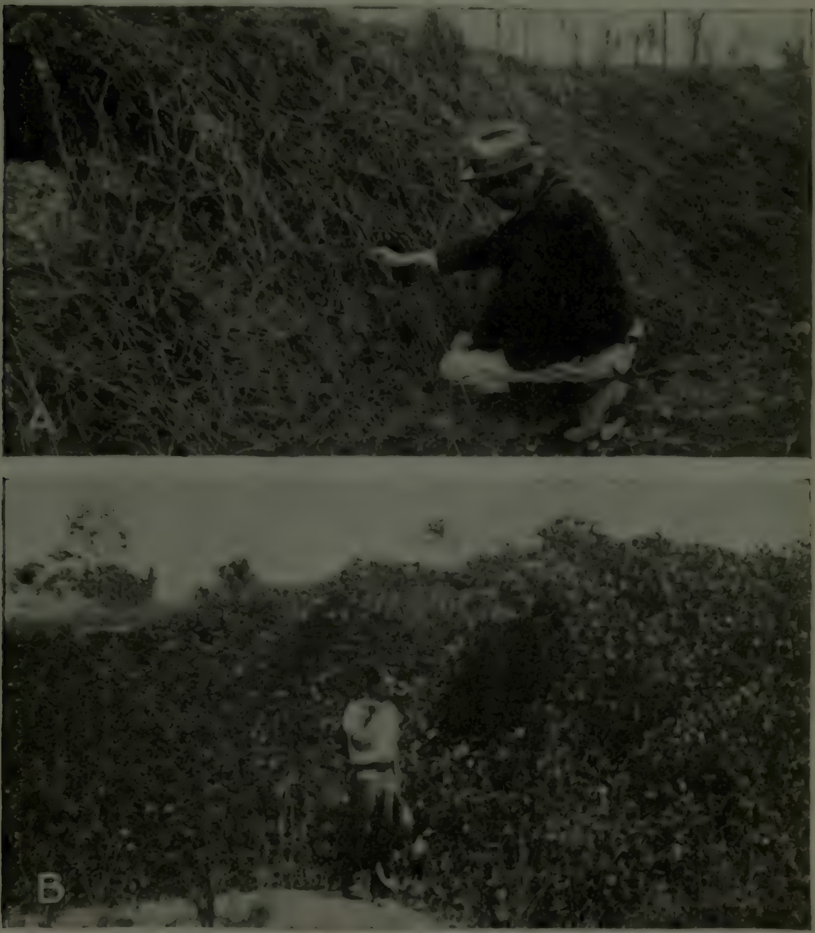
[2] See Leaflet 91, Kudzu a Forage Crop for the Southeast.



F242985

FIGURE 8.—Japanese honeysuckle and black locust plantings are very effective in erosion control. The appearance of this once actively eroding gully has been completely changed

In several instances kudzu has completely checked the growth of large gullies. In 1926 a landowner near Canton, Miss., planted kudzu in some huge washes on his farm. By 1930 the vines had spread to adjoining gullies and had covered several acres with a dense carpet of vines. (Fig. 9, B.) All active erosion had been stopped. Several gullies had been filled with soil 10 feet deep as the vines caught and held the soil washed from the gully banks. While at first the sandy outwash was of sufficient volume to bury the kudzu, this did not check the growth of the plant. The submerged vines immediately put out new shoots, which in turn caught and held more outwash material. This process occurred repeatedly until the soil became stable through the filling of the gully and the establishment of the protective carpet of vines.



F245113 F249776

FIGURE 9.—Kudzu vines have proved very effective on barren, eroded soils where a tree crop is not wanted: A, Kudzu vine carpeting the sandy banks of a reclaimed gully, affording soil protection even during the winter months; B, this dense mat of kudzu vines has, in four years, transformed the eroding gully banks into a stable soil capable of supporting a valuable forage crop

Kudzu produces little if any seed and must be grown from plants, commonly termed " roots " (or " crowns "). On favorable sites, kudzu will, in two or more years, produce large fleshy roots. Only roots having well-developed buds and thickened, perennial branches should be used for gully plantings. Kudzu roots suitable for planting are usually high in price, but if a few are started on a fertile soil in good physical tilth a plentiful supply of plants will be available after several years. In recent years the species has been introduced into many communities, and frequently there exists a local source of planting stock where the only cost is that of digging the plants. Kudzu roots should be set out during March. If a stand is to be obtained quickly—and this is especially desirable in erosion control—plants should be spaced about 8 feet apart. This spacing will require about 700 roots to the acre of gullies. Some farmers have experienced difficulty in getting the plant established. During the first year or two after being set the kudzu may be damaged by livestock and rodents. Winterkilling has also been reported. However, careful planting of healthy, 2-year-old plants, occasional cultivation to remove competing vegetation, and some protection from grazing will do much to insure good survival and a healthy stand.

FIGURE 10.—Vines of trailing wild bean (*Strophostyles helvola*) covering an eroding bank. Promising species such as this native legume should be tested for effectiveness in controlling erosion

Several other species of vines possess habits of growth which should make them of some use in gully plantings. One of these is the common ornamental wisteria (*Kraunhia frutescens*). In Marshall County, Miss., wisteria has escaped from cultivation and is growing vigorously in the loose sands of a large wash. The vines spread rapidly and soon cover the barren surfaces. Trumpetcreeper (*Bignonia radicans*), another well-known and commonly cultivated vine, frequently spreads profusely over the denuded surfaces of large gullies. In northern Mississippi, a promising native legume, trailing wild bean (*Strophostyles helvola*), has been observed growing in the clay loam soils of many roadside gullies. This wild bean produces vinelike runners which soon cover an eroded area (fig. 10), and considerable foliage which should make good forage. Although the species is an annual, it apparently is a prolific seeder and reproduces abundantly.

In the South many native legumes of creeping or prostrate forms become established naturally on impoverished eroded soils, but rarely occur in sufficient density to halt erosion. Those most commonly observed are piedmont butterfly-pea (*Bradburya virginiana*) and porcelain butterfly-pea (*Clitoria mariana*), tickclovers (*Meibomia* spp.), partridge pea (*Cassia fasciculata*), rattlebox (*Crotalaria* sp.), vetches (*Vicia* sp.), and various Lespedezas (*Lespedeza* spp.). (Fig. 11.) Although these legumes could no doubt be easily propagated, their use for gully plantings seems questionable.

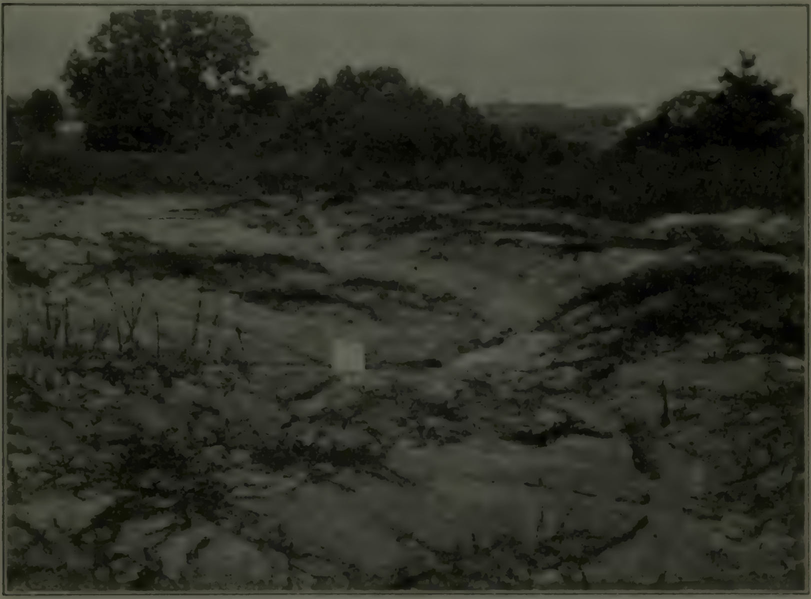


FIGURE 11.—Several native species of Lespedeza becoming established on the eroding soils of an abandoned field. The prostrate form is *Lespedeza repens*. Gullies at this stage will support a fair growth of vegetation and hence may be easily controlled and reclaimed

The well-known common Lespedeza (*Lespedeza striata*)[3] is very effective in controlling soil wash. Its effectiveness apparently lies not so much in the soil-binding power of the roots as in the production of a mat of protective foliage which clings closely to the soil. (Fig. 12.) Few plants can grow on a greater variety of soils than can this legume. Lespedeza seems particularly able to grow on heavy clays and other soils in poor physical condition. At the Mississippi Branch Experiment Station at Holly Springs, Miss., repeated attempts have been made to establish various grasses and forage plants on unproductive, barren areas resulting from the filling and leveling of large gullies. While Lespedeza failed to make a vigorous growth, it established itself more readily on these unfavorable sites than did the other plants, many of which could not be grown at all. It is a prolific seeder and during a normal year a good stand commonly produces 100 to 200 pounds of seed per acre. A few plants, comprising only a partial stand of Lespedeza, will usually provide abundant seed for seeding in surrounding unvegetated areas. A stand is usually obtained by preparing the soil and sowing in late winter from 20 to 25 pounds of fresh seed per acre.

---

[3] For further information, see Farmers' Bulletin 1143, Lespedeza as a Forage Crop.

USE OF GRASSES

Among the grasses effective in stopping soil loss, two are outstanding for use in the Gulf States. These are Bermuda grass (*Capriola dactylon*) and centipede grass (*Eremochloa ophiuroides*).

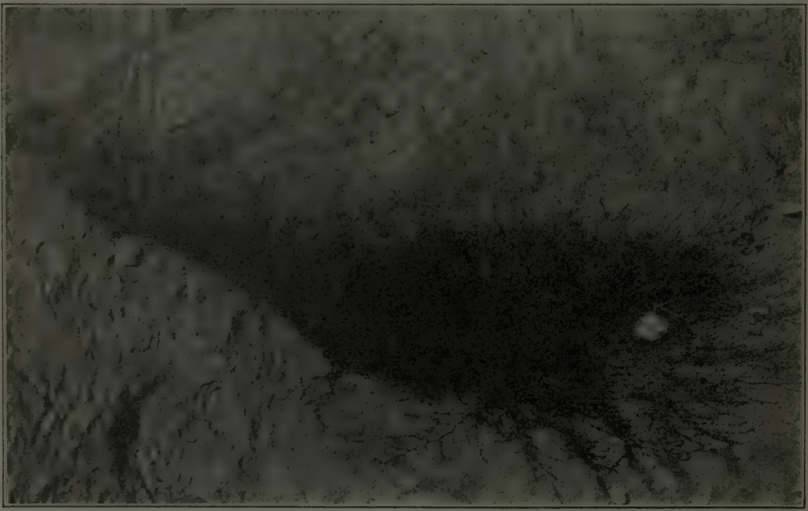
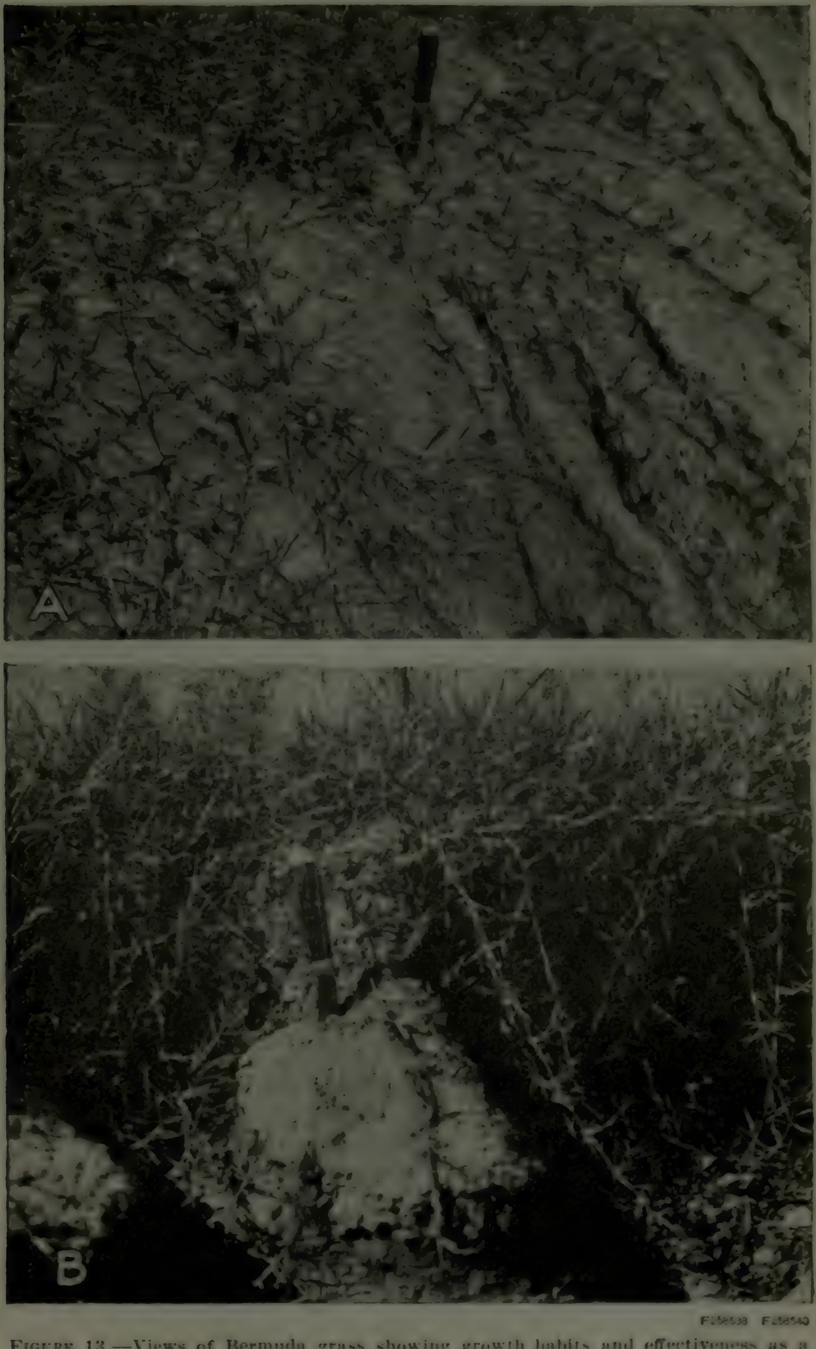


FIGURE 12.—Common Lespedeza (*Lespedeza striata*) growing in a wash. This species constitutes a valuable hay and forage crop in the Southern States and has become naturalized on gullied lands and waste areas

The soil-binding powers of Bermuda grass are too well known to need much discussion. This valuable forage plant has been much used in the South in maintaining levees and highway fills and slopes. Its rapid growth and the manner in which its interlocking rootstocks and runners encroach upon and soon cover an eroding spot render it an admirable grass for gully planting. (Fig. 13.) Many farmers report gradual filling of gullies in abandoned fields through the action of Bermuda grass in catching outwash. Although this plant will not grow on the more arid sites, it has been observed growing vigorously on deep sands as well as on refractory clay soils. It grows especially well on silt loams of loessial origin, and little difficulty should be experienced in securing a vigorous growth in gullies and washes in which loess soils are exposed.

Farmers have often looked with disfavor upon Bermuda grass because of its aggressive spread and the difficulty of eradicating it from fields in which it has become established. Most southern



F258538 F258540

FIGURE 13.—Views of Bermuda grass showing growth habits and effectiveness as a soil binder: A, Bermuda-grass stolons invading an eroding slope. In only a few weeks a dense sod will be formed. B, Bermuda grass checking active erosion in gully formed by the washing out of an old terrace

farmers, however, are becoming increasingly aware of its high forage value and its palatability during the late summer and in periods of drought when native vegetation furnishes little feed. Equally evident is its ability to reclaim soil through decay of its underground rootstocks and action of the stolons in checking surface flow of soil. Proper recognition has not been given to the advantages in converting worn-out fields to Bermuda-grass pasture rather than permitting them to erode or, at best, to become revegetated with innutritious and unpalatable native grasses.

Bermuda grass is easily propagated either by seed or by cuttings. About 5 pounds of seed per acre is the usual sowing rate. The commonest method of propagation, however, is to plant either cuttings made from the stolons or pieces of fresh Bermuda grass sod about 1 inch in thickness. If these are planted during the spring from 2 to 3 feet apart in rows 4 to 6 feet apart, the eroding soils, if not too unstable, should be well sodded by midsummer.

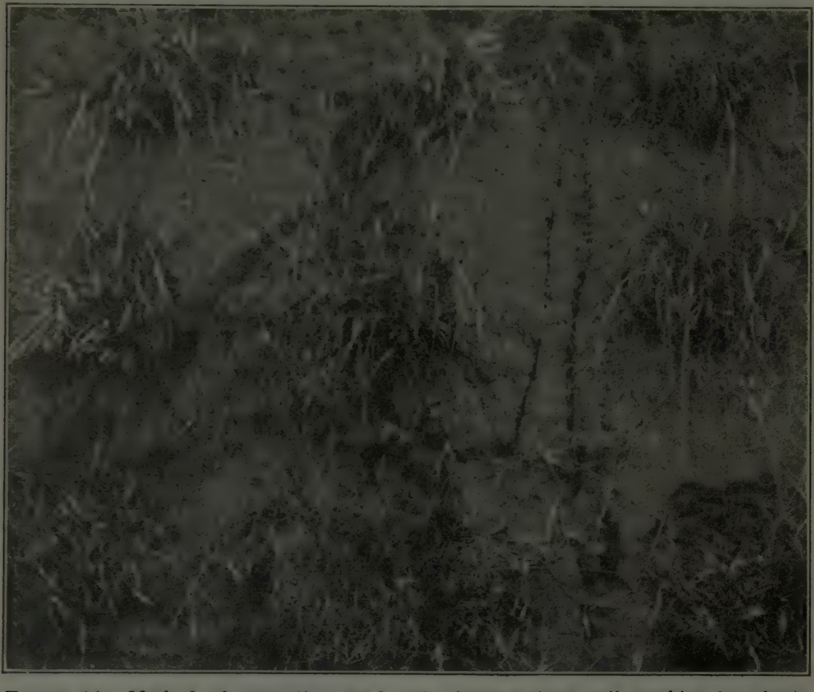


FIGURE 14.—Method of protecting road embankments from soil washing by planting Bermuda-grass turf or Johnson grass in pockets dug into the bank. A complete grass sod soon covers the slope

Centipede grass was introduced into this country in 1918 from the Province of Hunan, China, where it is a favorite lawn and pasture grass. It spreads by surface runners which take root at the nodes and send out new plants. The species does not develop underground rootstocks as does Bermuda grass, but it is equally effective in stopping soil movement and has the added advantage of being able to grow on extremely dry soils and thus to withstand droughts. At the McNeill branch of the Mississippi experiment station centipede grass has been grown successfully on an eroding, gravelly hillside which had repeatedly failed to support a growth of Bermuda or native grasses. This grass withstood the severe droughts of 1924 and 1925 and has since spread rapidly. Stolons have been known to make a growth of as much as 8 feet during a growing season. Although centipede grass is reported to have withstood winter temperatures of 12° F. in Georgia, it is perennial only in the Gulf States and may not prove winter hardy in latitudes north of northern Mississippi.

Centipede grass produces little seed and must be propagated vegetatively, and because the species has been so recently introduced into this country a supply of stolons and turf may not be readily available. However, certain commercial nurseries should be able to supply the demand for these materials until the species becomes better known and well established.

Many other grasses common in the South possess characteristics that should make them useful in controlling erosion. A few of these are carpet grass (*Axonopus compressus*), crabgrass (*Syntherisma sanguinale*), Dallis grass (*Paspalum dilatatum*), bents and redtop (*Agrostis* spp.), and Johnson grass (*Holcus halepensis*). All of these are hardy and have creeping or turf-forming habits of growth, and all except carpet grass, which requires a rather moist soil, are able to grow on dry, eroded situations. Of these, Johnson grass is the only one used to any extent for erosion control. This species is commonly used, either alone or in combination with Bermuda grass, for controlling erosion on the steep slopes of high road fills and embankments. (Fig. 14.) Because of its strong creeping rootstocks and rank growth, Johnson grass is an excellent soil binder as well as a good hay and soiling crop, although it becomes a weed in many cultivated fields in the South and is eradicated with difficulty.

Restoring the forests is probably the final means of reclaiming most of the areas denuded by gullying. Tree growth, once established, seems to afford the maximum soil protection under southern conditions. Initial tree plantings may be unsuccessful in rapidly eroding gullies and on unusually poor soils. In such cases soil-binding vines and grasses may be useful in stabilizing or building up the soil so that it will support the most effective soil-binding trees. The first problem in reclaiming large gullies is to check soil movement in the shortest possible time. Once the erosion is controlled other factors will determine the productive uses to which the land will be put.

Plants other than those mentioned in this bulletin—perhaps some exotic plants—may prove suitable for erosion-control plantings. However, the list given here should be helpful to the farmer or other landowner concerned with stopping the growth of large gullies and interested in experimenting with plantings and methods of control.[4]

---

[4] Persons in the South interested in planting gullied lands can obtain information on the sources and cost of planting stock and can get other advice from their State forestry departments, their agricultural extension services, or their county agents, or by writing the Southern Forest Experiment Station, Forest Service, U. S. Department of Agriculture, New Orleans, La.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	Arthur M. Hyde.
Assistant Secretary	R. W. Dunlap.
Director of Scientific Work	A. F. Woods.
Director of Regulatory Work	Walter G. Campbell.
Director of Extension Work	C. W. Warburton.
Director of Personnel and Business Administration.	W. W. Stockberger.
Director of Information	M. S. Eisenhower.
Solicitor	E. L. Marshall.
Bureau of Agricultural Economics	Nils A. Olsen, *Chief.*
Bureau of Agricultural Engineering	S. H. McCrory, *Chief.*
Bureau of Animal Industry	John R. Mohler, *Chief.*
Bureau of Biological Survey	Paul G. Redington, *Chief.*
Bureau of Chemistry and Soils	H. G. Knight, *Chief.*
Office of Cooperative Extension Work	C. B. Smith, *Chief.*
Bureau of Dairy Industry	O. E. Reed, *Chief.*
Bureau of Entomology	C. L. Marlatt, *Chief.*
Office of Experiment Stations	James T. Jardine, *Chief.*
Food and Drug Administration	Walter G. Campbell, *Director of Regulatory Work, in Charge.*
Forest Service	R. Y. Stuart, *Chief.*
Grain Futures Administration	J. W. T. Duvel, *Chief.*
Bureau of Home Economics	Louise Stanley, *Chief.*
Library	Claribel R. Barnett, *Librarian.*
Bureau of Plant Industry	William A. Taylor, *Chief.*
Bureau of Plant Quarantine	Lee A. Strong, *Chief.*
Bureau of Public Roads	Thomas H. MacDonald, *Chief.*
Weather Bureau	Charles F. Marvin, *Chief.*

U. S. GOVERNMENT PRINTING OFFICE: 1933

For sale by the Superintendent of Documents, Washington, D. C. - - - - - Price 5 cents

Ind

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1698

HEATING *The* FARM HOME

A WELL-HEATED HOUSE is essential to comfort of farm life in winter. In cold weather comfortable temperatures throughout the house are best assured by a properly designed central heating plant, which may be a pipeless or a piped warm-air furnace, a hot-water system, or a steam or vapor system.

Satisfactory results in home heating require that the heating plant have sufficient capacity, and be of a type adapted to the house and properly installed.

Comfort depends not only upon a good heating plant, but also upon proper construction of the house to prevent excessive air leakage around doors and windows and the escape of heat through walls and roof.

In this bulletin the requirements that should be met and the characteristics of different types of heating systems are discussed, and advice is given on selecting heating plants for farm homes and on ways of conserving heat.

This bulletin supersedes Farmers' Bulletins 1174, One-Register Furnaces, and 1194, Operating a Home Heating Plant.

Washington, D. C. Issued February, 1933

HEATING THE FARM HOME

By Arthur H. Senner, *Associate Mechanical Engineer, Division of Structures, Bureau of Agricultural Engineering*

CONTENTS

Page
Factors affecting health and comfort … 1
Requirements of a heating plant … 2
Proper size of heater … 2
The chimney flue … 3
Types of heating systems … 4
  Fireplaces and stoves … 4
  Warm-air system … 5
  Hot-water system … 8
  Steam system … 10
Types of boilers … 11
Installation costs of various systems … 12
Hot-water supply … 12
Page
Operation of the heating plant … 12
  Rules for preparing equipment … 13
  Kinds of fuel … 13
  Rules for burning large-size anthracite … 13
  Rules for burning coke with anthracite pea or buckwheat … 13
  Rules for burning wood with anthracite pea or buckwheat … 14
  Rules for burning bituminous coal … 14
Temperature regulators … 14
Ways of conserving heat … 14
  Reducing window and door leakage … 14
  Reducing heat losses through walls and roofs … 15

THE CHIEF POINTS to be considered in selecting a heating plant for the farm home are: First cost, operating costs, convenience, and durability.

The cost of heating a house depends principally upon: (1) The average outside temperature and the exposure of the house to winds; (2) the degree of weather tightness of the house; (3) the average temperature maintained inside the house; (4) the efficiency with which the fuel is burned and the heat transmitted to the several rooms (this depends upon the personal element as well as design of equipment); and (5) the unit cost of the fuel.

These factors have practically the same effect with all types of systems that are properly designed and installed, and operating costs of different types of systems are not very different, if the plants are handled with equal skill. Correct size and installation of a plant are much more important than its type. With stoves, for example, expenditures for fuel commonly are less than with furnaces because the former do not heat the same amount of space as the latter, or do not heat it to the same degree.

FACTORS AFFECTING HEALTH AND COMFORT

Most well-informed physicians and heating engineers are of the opinion that temperature, humidity, and motion are the most important conditions in the air we breathe. The temperature as indicated by a thermometer does not always give a true indication of the feeling of heat or cold. Dry air at ordinary room temperature may chill the body because it increases the rate of evaporation from the skin.

To restore the heated air of the house to approximately the normal moist condition of out-door air at comfortable temperatures may require the evaporation of one-half to three-fourths gallon of water per hour for even a comparatively small house. To vaporize this quantity of water and mix it with the air of the house would require special equipment, and with so much moisture in the air a great deal of dampness or frost would accumulate on windows in cold weather unless storm windows were used. Usually the humidity in a heated house is considerably below that out of doors.

REQUIREMENTS OF A HEATING PLANT

The heating system should be capable of maintaining comfortable temperatures, should be easily controlled, and should require a minimum of attention. If the entire house is to be heated, these requirements are best met by a plant of the central type; that is, a single boiler or furnace connected with the various rooms by ducts or piping.

The heater should be able to use, economically, a reasonably wide variety of fuels, depending on those available in the vicinity. Most of the furnaces or boilers used in modern heating systems operate most satisfactorily with hard coal and coke. Soft coal produces more smoke and flues and heating surfaces require more frequent cleaning if it is used. However, on account of its lower cost and wider distribution, soft coal is used more generally than anthracite. The smoke is of course less objectionable in the country than in thickly populated areas. Oil and gas can also be burned in heating plants equipped with suitable burners but their efficiency is not always equal to that of solid fuels.[1]

The heating system should be rugged and free from mechanism or accessories that require frequent adjustment or replacement. Pipes, ducts, radiators, and boiler or furnace must be properly proportioned and installed.[2]

PROPER SIZE OF HEATER

The heating system must be so proportioned and installed as to heat the house satisfactorily when the outside weather conditions are most severe. Furthermore, it should have some reserve capacity in order to raise the house temperature fairly rapidly.

Table 1 gives the grate area of a boiler, furnace, stove, or convection-type heater required to maintain an inside temperature of 70° F. under the various outside temperatures indicated. This table must be followed with discretion; a poorly built house will obviously require a heating unit of larger grate area than that indicated.

---

[1] See Department Circular 405, The Domestic Oil Burner.

[2] Reputable dealers, including the larger mail-order houses, usually design and guarantee proper installation.

TABLE 1.—*Square feet of grate area required to maintain an inside temperature of 70° F. in houses of average construction and under various outside temperatures*

Volume of house excluding cellar (cubic feet)	Square feet of grate area required when the lowest ordinary outside temperature is—				
	+20° F.	+10° F.	0° F.	−10° F.	−20° F.
2,000	1	1	1¼	1½	1¾
4,000	1¼	1½	1¾	2	2¼
6,000	1½	1¾	2	2¼	2¾
8,000	1¾	2	2½	2¾	3
10,000	2	2½	2¾	3	3½
15,000	2½	3	3½	4	4½
20,000	3	3¾	4½	5	5½
25,000	3¾	4½	5¼	6	6¾

A room 10 feet wide, 12 feet long, and 8 feet high contains approximately 1,000 cubic feet.

Round grates have areas approximately as shown in Table 2.

TABLE 2.—*Areas of round grates*

Diameter of grate (inches)	14	16	18	20	22	24	26	28
Area of grate (square feet)	1.1	1.4	1.8	2.1	2.6	3.1	3.7	4.3

The area of a rectangular grate, in square feet, is found by multiplying the width of the grate in inches by its length in inches and dividing by 144.

THE CHIMNEY FLUE

The construction of the chimney flue should minimize the fire hazard, and its dimensions should assure an adequate air supply or draft. Details of construction are given in other bulletins of this department.[3] Dimensions of the flue depend upon the size and type of the heating plant to be installed and the kind of fuel to be burned. These facts should be determined before construction of the flue is begun. If the chimney is inadequate the only method of improving it, short of reconstructing it, is to increase its height. This is not always effective and often is impracticable.

Certain general rules for constructing flues can be stated. A chimney flue should have a fire-clay lining and should be as nearly straight from the bottom to the top as possible. The flue should have no openings except that for the smoke pipe from the main heater and a clean-out door. The cross-sectional area of the flue must not be reduced at any point. The clean-out door should make a tight joint with its frame when closed.

Table 3 gives the sizes of chimneys ordinarily provided for boilers, furnaces, stoves, or convection heaters burning soft coal. These sizes have proved satisfactory for average flat-grate furnaces under normal conditions. Manufacturers of heating equipment usually specify certain requirements in chimney construction and will not guarantee the performance of their heaters unless these requirements are met.

---

[3] Farmers' Bulletins 1590, Fire-Protective Construction on the Farm, and 1649, Construction of Chimneys and Fireplaces, contain information on chimney construction.

Therefore, these recommendations should be followed when they differ materially from the chimney dimensions given in this bulletin.

TABLE 3.—*Sizes of chimney flue linings and heights of chimneys recommended for flat-grate furnaces burning soft coal*[1]

Grate area	Outside size of chimney flue lining		Height of chimney flue above grate	Grate area	Outside size of chimney flue lining		Height of chimney flue above grate
	Round (diameter)	Rectangular			Round (diameter)	Rectangular	
Square feet	*Inches*	*Inches*	*Feet*	*Square feet*	*Inches*	*Inches*	*Feet*
1	9½	8½ x 8½	22	6	17¼	18 x 18	30
2	11¾	8½ x 13	24	7	20½	20 x 20	32
3	13	13 x 13	26	8	20½	20 x 20	35
4	13	13 x 13	30	9	20½	20 x 20	35
5	13	13 x 13	32	10	20½	20 x 20	40

[1] If anthracite coal is to be burned the area of the chimney may be reduced by about 25 per cent.

TYPES OF HEATING SYSTEMS

Farmhouses may be heated by any one of several devices, including fireplaces, stoves, circulator heaters, warm-air, hot-water, and steam systems. The pipeless furnace (so called), the piped warm-air, steam, and vapor systems, as ordinarily used in domestic heating, require cellars. Fireplaces, stoves, circulator heaters, and hot-water heating systems may be used without cellars, though a cellar is desirable for a hot-water system because it makes possible greater cleanliness and better appearance and because such a system generally functions better when the boiler is located below the level of the lowest radiator.

To provide a cellar[4] or pit for the boiler or furnace only a portion of the ground under the house need be excavated. The supply lines or air ducts can be installed in the space between the floor of the building and the ground. An excavation 12 by 15 feet is large enough for the boiler or furnace, coal storage, and stairs. The heater and a small supply of coal can be put into a pit about 10 feet square. It is necessary, of course, to extend the chimney below the floor and to provide an opening for the smoke pipe.

FIREPLACES AND STOVES

The chief advantages of a fireplace are its simplicity of operation, its cheerful effect, and the dignity and homelike character which it adds to a room. Its chief disadvantage is that a large part of the heat from it passes up the chimney and is lost. A fire in the fireplace provides heat quickly and almost any kind of combustible material may be used for fuel. Its warmth is radiant heat that warms objects close to the fire, but not the entire room. A properly constructed arch increases the amount of heat thrown off.[5] Fireplaces are frequently the only sources of heat for single rooms or small houses in mild climates, but in the north their usefulness is limited chiefly to taking the chill off a room when the main heating plant is not in operation.

---

[4] Farmers' Bulletin 1572, Making Cellars Dry, contains valuable information on constructing cellars.

[5] The construction of fireplaces and chimneys is described in Farmers' Bulletin 1649.

Stoves utilize fuel more efficiently than fireplaces, since they give off heat on all sides and there is considerable circulation of air warmed by contact with the stove. The loss of heat up the chimney is much less than from a fireplace since the draft is controlled much better. In cold climates a stove is needed for each two or three connecting rooms, or for each room if the doors are kept closed. If the entire house is to be heated by stoves, chimneys must be so located that proper flue connections can be made. In mild climates a single stove may provide sufficient heat for the entire house. The chief advantages of heating by stoves are their low cost, ease of installation, quick heat (especially if wood is burned), and adaptability to a house having no cellar. Disadvantages of stoves are the uneven distribution of heat, the frequent attention usually required, and the necessity of carrying fuel into and ashes out of the living quarters. Furthermore, when a stove is in use it must be set at a safe distance from walls and furniture, and therefore occupies a large space in the room. Stoves seldom harmonize with the other furnishings, and are a frequent cause of accidents to small children.

The cheapest heating stoves are made of sheet iron and have no grates. They use only wood, which they burn efficiently. Such stoves are generally short-lived and are not convenient for heating water. Cast-iron stoves with grates burn either wood or coal and are durable. Oil burners are now available for kitchen ranges, heating stoves, and the circulators or parlor heaters. They use kerosene or the lighter distillate oil fuels. Circulator heaters described on page 6 are now preferred to the more elaborate types of stoves. Ordinary ranges, cookstoves, and laundry stoves will usually warm the rooms in which they are placed. When provided with water backs or coils, they are useful for heating a piped supply of water for household use. Laundry stoves can also be used for a limited amount of cooking.

Equipment manufactured by a reliable concern should be selected in order to be assured of good quality of material and workmanship. A heating stove should be placed on a fireproof mat or base at least 18 inches from any unprotected plaster or woodwork. Smoke pipes should never be run through a partition unless special care is taken to protect the wood from heat.[6]

WARM-AIR SYSTEM

The advantages of the warm-air system are: (1) Its cost of installation is comparatively low; (2) the air motion it produces is desirable for comfort; (3) some moisture can readily be added to the air by means of water pans inside the outer shell of the furnace; (4) ordinarily the temperature is easily regulated, and can be quickly lowered or raised; (5) the system does not require accessories involving expense for upkeep; and (6) it will not be damaged by freezing if the fire is out during cold weather. On the other hand most warm-air systems do not work properly if the room doors are closed, and odors are carried from room to room by circulation of the air.

---

[6] See Farmers' Bulletin 1590, Fire Protective Construction on the Farm.

It is sometimes said that a warm-air heating system allows more chance than do other systems for coal-gas or oil fumes to leak into the house because of bad joints in the furnace. Gas-tight steel furnaces which even the intense heat of the oil burner does not cause to leak can now be obtained. Joints in furnaces of other types require periodical inspection and repair. It is best to have an experienced sheet-metal worker install a piped warm-air system.

Warm-air furnaces successfully burn various grades of anthracite, bituminous coal, coke, or chunks of wood. Oil burners are about as effective with these furnaces as with other types.

The simplest form of the warm-air system is the parlor furnace or circulator heater. (Fig. 1.) The advantages of such heaters as compared with stoves are that they give stronger air circulation and better distribution of heat, have a better appearance, and offer less risk since the outer surface is comparatively cool.

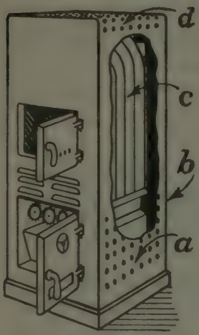


FIGURE 1.—Parlor furnace or circulator heater: *a*, Base grille through which air is drawn to be heated; *b*, casing; *c*, heating surface; *d*, top grille through which warm air rises into room

Such a unit may be placed in a convenient location on the floor to be heated and in a location where good air circulation can be obtained. The cold air is drawn into the grille work shown at *a* and passes up between the casing *b* and the heating surface *c*, the warm air emerging from the grille work *d* in the top of the casing. From this point, the air rises and circulates through the house, returning after cooling to be reheated. Such heating units are generally made to heat from two to eight rooms. They are especially successful in mild climates.

The pipeless (1-register) furnace is similar to the circulator heater. It is essentially a stove inclosed by two metal jackets, one outside the other. As the hot air leaves the central part of the register or heat outlet of the furnace, it rises and diffuses through the several rooms as shown by the arrows in Figure 2. An additional register placed in the first-floor ceiling may assist in heating a second-floor hall or room directly above. Under some conditions, however, the ceiling register may act as a cold-air return rather than as a warm-air passage. The principal limitations of the pipeless furnace are: It is difficult to obtain even distribution of heat in rooms which do not communicate directly with the room or hall in which the register is located; and closing the door shuts off the heat supply from a room, unless a transom or grille is provided.

A pipeless furnace will not provide the most uniform temperature conditions. On the other hand, it is the cheapest type of central heating system of which the heater can be placed in the cellar, thus avoiding considerable dirt and smudge in the living rooms. Manufacturers furnish instructions which enable a handy man to erect such a unit with little difficulty. The services of a sheet-metal worker or plumber are not necessary, but trained workmen can make the most satisfactory installations.

The piped warm-air furnace shown in Figure 3 is similar to the pipeless furnace, but distributes heated air to the various parts of

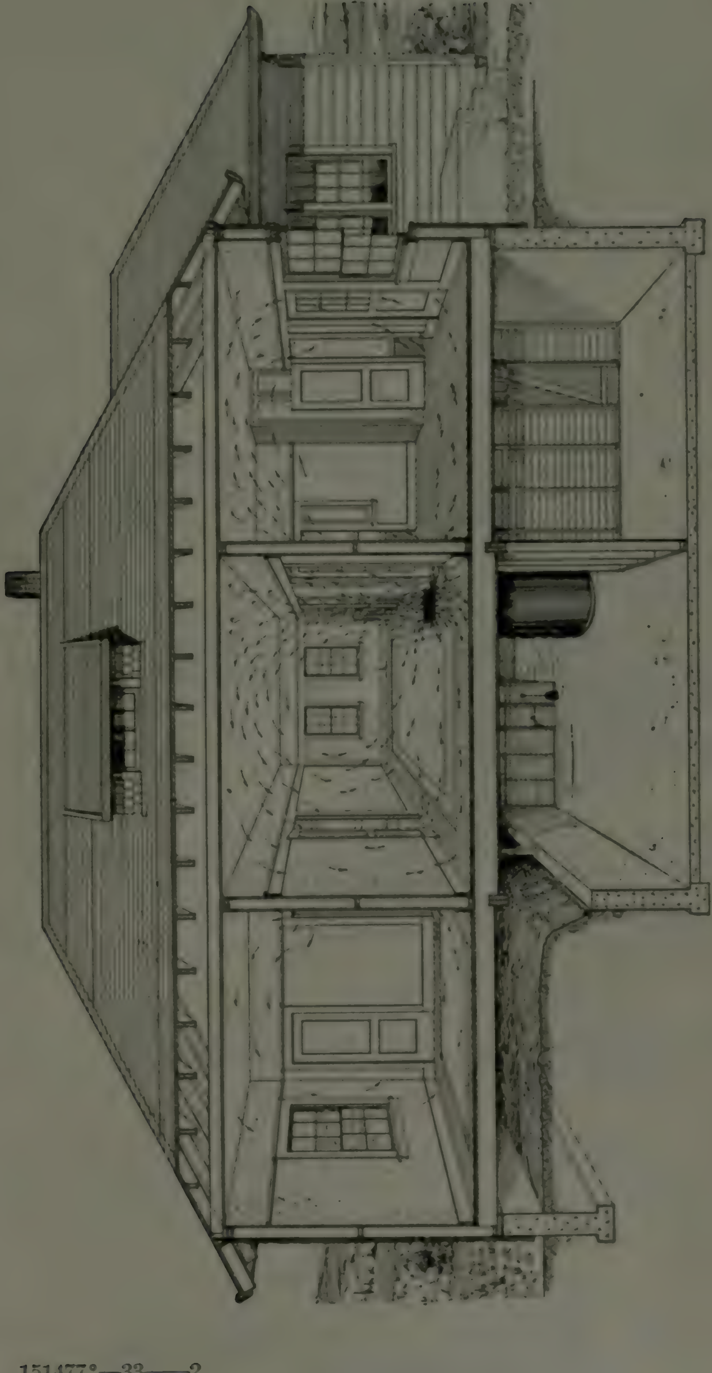


FIGURE 2.—Small house heated by pipeless furnace

the building through sheet-metal pipes. In general, the horizontal length of a duct should not exceed 15 or 20 feet. Usually the cold air returns from the various rooms through open doors, halls, or stairway, to a common cold-air return leading from the lower floor to the furnace. Separate return ducts may be installed for rooms usually kept closed.

Sometimes part of the air supply is taken from outside the building through a dampered pipe. In no case should it be taken from the cellar, since to do so would circulate cellar dust through the house.

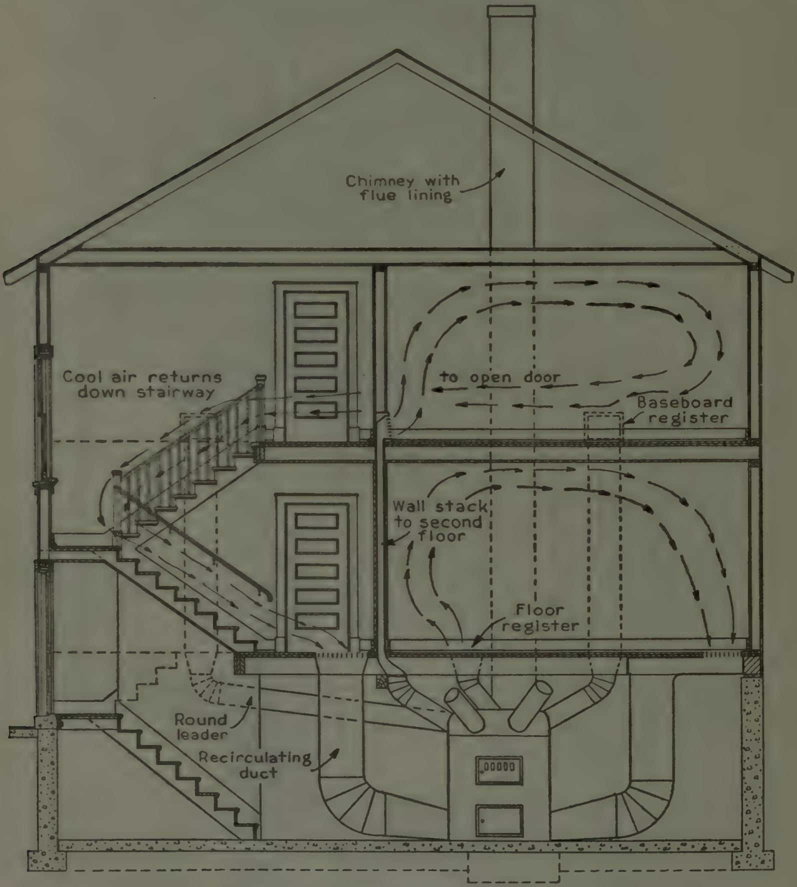


FIGURE 3.—Piped warm-air system

The most economical method is to recirculate the air within the house, as first described, and to admit air for ventilation by opening windows. In many houses leakage admits sufficient air for ventilation.

HOT-WATER SYSTEM

The hot-water heating system uses hot water to convey heat from the furnace to radiators in the rooms. Generally the boiler is placed in the cellar, and the radiators connected to it by pipes. Since hot water is lighter than cold, the water heated in the boiler flows to the radiators and in giving off its heat there cools and then returns by gravity to the boiler. The radiators are nearly always placed against outside walls, and often under windows.

Advantages of the hot-water heating system are: It is rugged and free from accessories that need adjustment; it can be controlled to meet a wide range of outside temperatures; the boiler generally is equipped with automatic draft-operating devices; a large amount of heat is stored in the circulating water and thus prevents sudden fluctuation of room temperatures; and the system can be installed satisfactorily in a house having no cellar.

Disadvantages of the hot-water system are: It will not meet quick changes in temperature; moisture can not readily be added to the air; and if the fire goes out during very cold weather, the water must be drained from the system to prevent serious damage from freezing.

It is best to have an experienced heating contractor install a hot-water system.

A hot-water installation in a building without a cellar is shown in Figure 4. The piping is shown exposed, although if the system is installed when the house is built the main lines, at least, may be concealed. The boiler generally provides enough heat in the room where it is located. The supply lines are run overhead, pitching down gradually from a high point over the boiler to the vertical feeders to the radiators. The lines carrying the water back to the boiler are shown at the floor line in Figure 4. In small systems of the type shown, control valves at the radiators are frequently omitted.

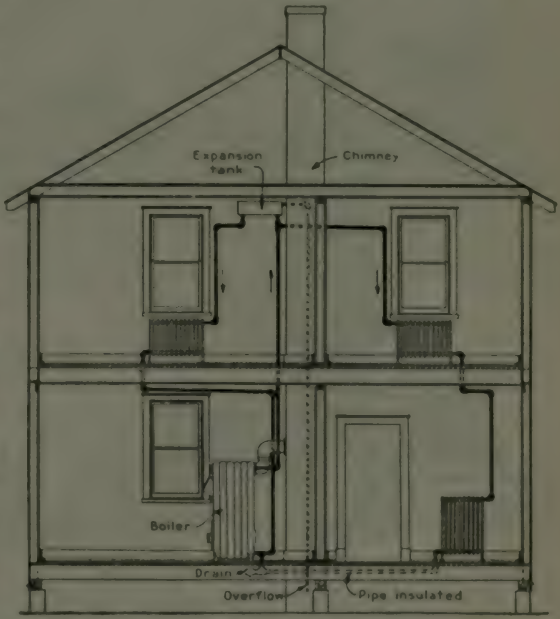


FIGURE 4.—Hot-water system in house without cellar

In the ordinary "open" hot-water system, as illustrated in Figures 4 and 5, an expansion tank with overflow allows for expansion of the water as it is heated. In practice the water is seldom heated above 180° F. The expansion tank must be placed where it will not freeze.

In the newer "closed" system, the water is held under pressure of 15 to 30 pounds per square inch, and may therefore be heated to much higher temperatures than in the open system, making circulation more positive. The closed system is gaining in popularity. Smaller pipes and radiators may be used with it than with the open system. The capacity of an open system having insufficient radiation can sometimes be increased by converting it to the closed type.

No open tank is used in the closed system. If the pressure becomes excessive, a relief valve opens, permitting a little water to discharge to the floor drain. When the pressure in the heating system drops below the desired level, a reducing valve admits water from the house supply. A reliable relief valve is necessary in the closed system but the amount of heat lost through occasional venting of water is negligible if the system has been properly installed and adjusted. There should be no material difference in fuel consumption between the open and closed systems, other things being equal.

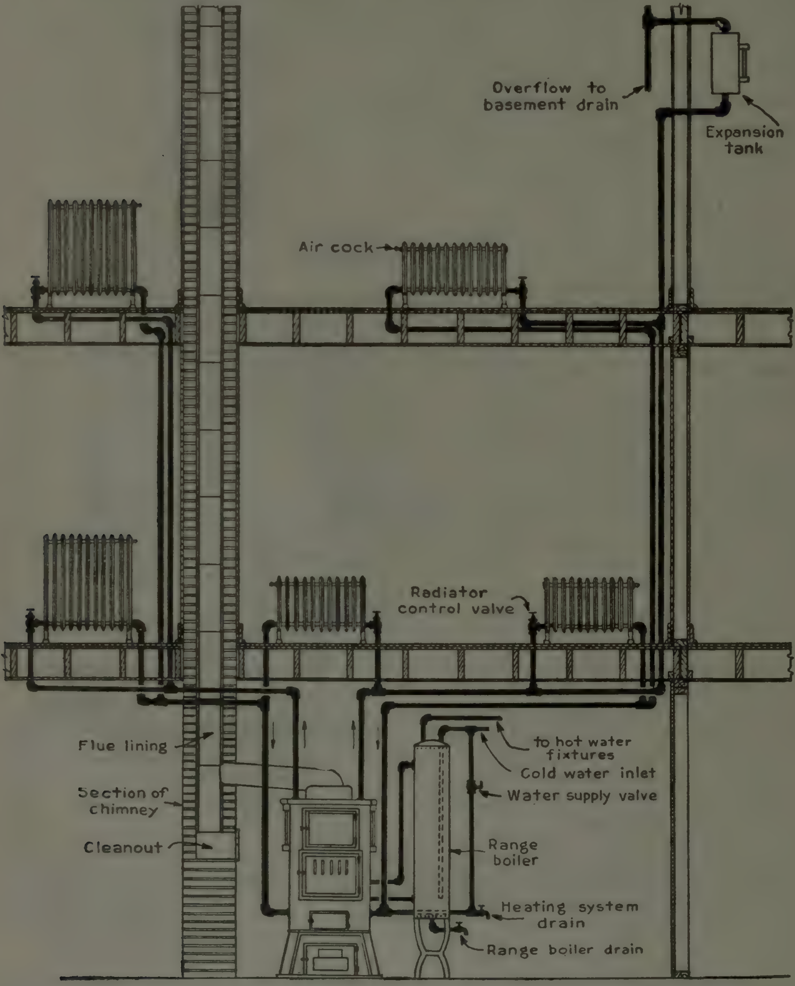


FIGURE 5.—Hot-water heating system with boiler in cellar

STEAM SYSTEM

A steam heating system consists of a boiler and a system of pipes connecting it with the radiators, which are usually placed next to the outside walls. Steam from the boiler passes into the pipes and through them to the various radiators where it gives up its heat and condenses into water which returns to the boiler by gravity. There are several modifications of the steam heating system. Often the amount of piping and radiation required is considerably less than for a hot-water system, on account of the higher temperature of the steam. As with the hot-water system, it is best to have an experienced heating contractor install a steam heating plant.

Of the steam systems the 1-pipe type is the simplest and perhaps the most satisfactory for the average farm home. The steam is conducted to the radiators and the condensed water returned to the boilers through the same pipe. In the 2-pipe system the condensed water returns to the boiler through separate pipes.

All radiators must be fitted with valves to allow the escape of air as steam fills the system. These may operate merely to allow escape of air, or may also act to maintain a partial vacuum in the system when steam pressure falls, thus increasing the time during which the radiators are warm.

The advantages of the steam system are: Its cost is low as compared with that of other types of radiator heating; smaller radiators are required than for the other systems; the room temperature can be raised rapidly; and the system is practically free from accessories requiring attention. The principal disadvantage of the ordinary steam heating system is that it contains very little stored heat and therefore requires more attention to the fire than do any of the other systems.

The vapor system is a modification of the 2-pipe steam system. The air is vented and condensed water returned to the boiler through a return trap installed on the return main near the boiler. The vapor system permits operation at lower steam pressures and requires less attention than does the ordinary steam system. It permits closer regulation of the flow of heat to individual radiators.

Since the condensed water from the radiators returns to the boiler by gravity, the boiler for an ordinary simple steam system or vapor system must be in the cellar.

TYPES OF BOILERS

Boilers for steam and for hot-water heating systems are made in several styles, with no great difference in their efficiency. Perhaps the simplest type is that shown in Figure 4. It is suitable only for small hot-water jobs where there is no cellar. The heater is compact and the doors fit well enough to keep most of the dirt and soot out of the rooms.

Boilers for larger houses may be either round or rectangular. Both types are, as a rule, built in sections. Sectional boilers burn most of the grades of solid fuel satisfactorily, and may be equipped to burn oil. The differences for hot water or steam are very slight. Such boilers are usually equipped with automatic temperature or pressure controls. Some manufacturers provide attractive enameled sheet-metal coverings (fig. 6) with insulation between the coverings and the boiler proper. Otherwise some form of plastic insulation is generally applied after installation. The insulated sheet-metal covering costs practically the same as the plastic insulation and is far more satisfactory. Plastic coverings generally flake or chip off.

The magazine-feed type of cast-iron boiler is designed to burn small-size anthracite, coke, or graded noncoking bituminous coal. It can not be used with coals which form a crust. The fuel is put into the magazine above a sloping grate and forms an inclined fire bed which always maintains practically the same thickness, since, as fast as the fuel burns, it shrinks and settles on the grate, thus allowing an additional supply to flow down by gravity from the magazine. The magazine-feed boiler is well adapted for use with automatic room-temperature-control devices because of its self-feeding principle and the large storage of fuel. For a given capacity the price of the magazine-feed boiler may be somewhat higher than that of the ordinary cast-iron flat-grate boiler shown in Figure 6.

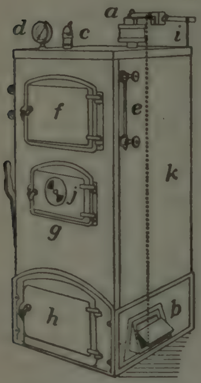


FIGURE 6.—Sectional boiler with sheet-metal jacket: *a*, Steam-pressure regulator; *b*, primary draft damper; *c*, safety valve; *d*, steam-pressure gauge; *e*, water glass; *f*, flue clean-out door; *g*, fire door; *h*, ash-pit door; *i*, rod to check and choke damper; *j*, secondary air damper; *k*, enameled-steel insulated jacket

INSTALLATION COSTS OF VARIOUS SYSTEMS

An estimate of the cost of any particular installation can be had by submitting complete specifications and plans to one or more heating contractors or supply houses. Relative costs of the several types, expressed in percentage of the cost of 1-pipe steam system, are about as follows:

	Per Cent
2-pipe vapor system	150
2-pipe hot-water system	125
1-pipe steam system	100
Piped warm-air furnace	65
Pipeless furnace	35
Circulator heaters or stoves	15

For example, if a 2-pipe hot-water system for a 6-room house costs $500, the other types of heating systems for the same house ordinarily would cost about as follows: 2-pipe vapor system, $600, 1-pipe steam system $400; piped warm-air furnace $260; pipeless furnace $140; circulator heater or stove, $60. As already explained, these systems do not furnish equal degrees of comfort, and are not equally adapted to all types of houses.

HOT-WATER SUPPLY[7]

A supply of hot water for household use may be obtained from the heating system by use of a fire-pot heater or an indirect heater. Either type will provide reasonable quantities of hot water during the heating season at small cost.

OPERATION OF THE HEATING PLANT

The efficiency and operation of a heating plant can be improved by observing certain rules.

The manufacturers of furnaces and boilers generally supply printed operating instructions. If not received with the equipment they should be requested from the nearest agent or from the manufacturer, the size and serial number of the heater being given with the request. Some coal dealers distribute, free, excellent printed instructions for operating the furnace with the particular fuel furnished.

---

[7] Farmers' Bulletin 1426, Farm Plumbing, contains detailed practical information on domestic water heating.

The ash pit should always be kept clean, as an accumulation of ashes under the grates may cause them to be burned or warped, with consequent waste of fuel and difficult operation. The flues should be cleaned regularly to insure proper draft and heating.

The following rules and information on equipment and fuels have been adapted from a folder prepared by the fuels division of the American Society of Mechanical Engineers. When this folder was issued the society estimated that from 10 to 20 per cent of the fuel usually required could be saved by observing these rules:

RULES FOR PREPARING EQUIPMENT

See that the grates are in good order.

Seal air leaks in ash pit and around clean-out doors.

Arrange coal bins so that two kinds of fuel can be kept separate.

KINDS OF FUEL

Stove and nut anthracite are ideal fuels for heating homes, but scarcity and cost restrict their use.

Gas coke burns excellently with anthracite pea or buckwheat, making a fire that will keep well and give heat when required.

Wood chunks, in combination with anthracite pea or buckwheat, make good fuel. They are equal to coke for producing heat, but require more attention. Wood chunks may be burned alone satisfactorily in furnaces with tight doors.

Bituminous coal can be used in most furnaces designed for hard coal, unless the flue passages are small and not easily cleaned. Bituminous coal demands more attention, and unless it is given will produce less heat. A heater of adequate size should be provided so that the fire need not be forced.

RULES FOR BURNING LARGE-SIZE ANTHRACITE

Carry a deep bed of fuel, at least level with fire doors.

Shake the grate to remove ashes and lower the fuel bed, but stop when the first live coals appear.

Fresh fuel should be spread evenly over the entire grate area. A heavy firing, 6 to 8 inches deep, can be made if desired and will last for six to eight hours. For quick kindling, the fire bed should be made fairly hot before fresh fuel is added.

After firing keep the dampers wide open until blue flame appears, then check the draft as much as necessary to keep the fire burning at the desired rate. The proper setting of the dampers for a given furnace must be learned by experience because of the variation in the draft available. In mild weather the fire may be checked effectively by allowing a bed of ashes to accumulate on—not under—the grate.

RULES FOR BURNING COKE WITH ANTHRACITE PEA OR BUCKWHEAT

Carry a deep bed of fuel even above the level of the fire door.

Shake the grate to remove ashes and lower the fuel bed, but stop when the first live coals appear.

Spread a thin layer of anthracite over the entire grate area and allow a few minutes for it to ignite. Next, fill the fire pot with coke, and allow this to burn until blue flame appears, then add another layer of anthracite.

After the charge is ignited, check the draft to the desired point.

When banking the fire for the night, use less coke and more anthracite, but otherwise fire in the manner described above.

Anthracite pea or buckwheat can often be used alone with success, if the draft is unusually good and the furnace amply large. Small-size anthracite ignites slowly. It is best to fire one-half of the grate at a time, allowing the first half of the charge to ignite before adding the second half. Small sizes of coal may be used in the fall and spring if not in the winter.

RULES FOR BURNING WOOD WITH ANTHRACITE PEA OR BUCKWHEAT

Follow the rules for coke and anthracite, substituting wood chunks for coke. It is highly important to see that the fuel is properly ignited and giving off flame before closing the drafts.

RULES FOR BURNING BITUMINOUS COAL

Bituminous or soft coal usually gives less heat than anthracite when fired in the ordinary residence heater, and therefore requires more attention.

A deep fuel bed is desirable and, as a rule, more draft is required.

Stir up the fire and get it hot before adding new fuel.

Before firing a new charge, push the partly burned fuel to the back or sides of the fire box, heaping it high on the sides of the fire-box walls. Place fresh fuel in the hole in the hot fuel bed, making it level with the heaped-up burning fuel. Never smother the fire by covering it completely with fine coal; always see that there is some flame showing.

After firing, check the draft to make the fire burn slowly, setting the dampers as found best by experience.

A large charge of soft coal will burn slowly for several hours, giving out moderate heat. If more heat is demanded it can be had by breaking up the partly ignited mass.

A little air should be admitted through the slides in the fire door.

TEMPERATURE REGULATORS

Temperature regulators for the ordinary coal-burning heating system are becoming increasingly popular. Such devices generally operate the dampers of the furnace according to the demand for heat in the house. The simplest type, however, merely opens the dampers at a certain time, and the dampers must later be closed by hand. Usually such controls may be obtained from local plumbers or from mail-order houses, at a cost of $5 to $10 including all necessary chain, pulley, etc. They can readily be installed by the house owner.

The more elaborate types of regulators maintain the desired night and day room temperature continuously. The simpler type of these controls obtains its motive power from a hand-wound spring, with two small electric dry cells for the thermostat circuit. In addition to saving labor, such devices may accomplish a substantial saving in fuel by preventing overheating. This type of temperature-control apparatus generally sells for $30 to $100, depending upon its completeness and quality.

WAYS OF CONSERVING HEAT[8]

If it is to be heated properly and economically a house must be tightly constructed. Heat is lost through walls, roof, and windows and through openings and cracks. Most farmhouses can be made more comfortable at small cost by applying insulation or by correcting construction defects.[9]

REDUCING WINDOW AND DOOR LEAKAGE

Storm or double sash provide an air space between the two layers of glass and also lessen infiltration of air, thus greatly reducing the heat loss. Frost is much less likely to form on windows with storm sash. If hinged at the top and fitted with proper fastenings the storm sash may be swung open for ventilation. Storm doors have the same advantages as storm windows and also help to shut out drafts when persons enter or leave the house. Temporary vestibules at main entrances are very effective in preventing loss of heat.

---

[8] The author is indebted to T. A. H. Miller of the Division of Plans and Service, Bureau of Agricultural Engineering, for assistance in the preparation of this section.

[9] House Insulation, a bulletin prepared by the National Committee on Wood Utilization and issued by the U. S. Department of Commerce, describes the use of various insulating materials. For sale by the Superintendent of Documents, Washington, D. C., price 10 cents.

Wood and felt weather stripping, properly installed, aids materially in keeping out cold air. It should be applied on the outside of the upper sash, and usually on the inside of the lower sash. The felt should be placed so close that more than ordinary effort is required to open the window, and so that the door must be pushed hard to lock. When first applied this stripping is highly efficient but may not remain so long. Many persons object to its appearance.

Strip felting may be used like wood and felt stripping, or forced into cracks. As a temporary expedient, strip felting may be used on the inside of all windows by tacking it around the frame so that it rests against the sash. It can also be used to close cracks under doors.

Metal weather-stripping is very efficient in reducing crack leakage around windows and aids in making a house weather-tight. It is obtainable in various forms. To install it the window sash must be removed and grooves cut to receive the metal strips. When the work is properly done most of the stripping is hidden, the exposed part has a neat appearance, and windows slide easily. Metal weather-stripping for outside doors is also helpful.

Tight thresholds under bedroom doors prevent cold drafts into other rooms when windows are open.

REDUCING HEAT LOSSES THROUGH WALLS AND ROOFS

Much heat is often lost through the roof, as can be seen on a frosty morning, when frost clings to the overhanging gables and eaves but quickly melts from that portion of the roof through which heat is escaping.

When the ceiling joists are covered only with lath and plaster on the lower side, heat readily escapes from the rooms below. There are several remedies such as flexible insulating material between the joists; board insulation nailed on top and later covered by flooring if needed; or a layer of noncombustible granular material over the plaster and between the joists. When the ceiling joists are covered on both top and bottom, all openings between joists at the eaves should be blocked to shut out cold drafts. (Fig. 7, C.) Where the attic is to be heated, the insulation should be nailed to the underside of the roof rafters and on the end walls to serve also as a wall finish.

Sometimes there are large cracks at the eaves because sheathing and siding were not extended between the rafters. They can be closed by nailing blocks between the rafters or by being sealed with plastic materials.

Wall openings for windows and doors often admit cold drafts. A house is sheathed before the window and door frames are set, consequently the sheathing is not fitted snugly against the frame, and only the trim obstructs the entrance of cold air. To remedy this, the outside trim may be removed and a piece of heavy felt or painted metal used to seal the openings. The joints will be tighter if the back of the trim is given a heavy coat of paint before being nailed in place.

Frames in masonry walls become loose and the resulting opening between frame and masonry should be calked by forcing oakum, coated with plastic roofer's cement, into the cracks with a putty knife or a broad-faced calking iron; mortar commonly used for this purpose will not provide a permanently tight joint. Small cracks can be stopped with putty if they are carefully filled.

Siding which has become loosened by shrinking, warping, or action of the weather, should be tightened with rust-resistant nails. A good coat of paint and the liberal use of putty will seal many small cracks after the siding is tightened. A very effective and practical method of insulating frame houses on which the siding is defective or poorly installed, is to shingle the outside of the walls, using a heavy building felt between the shingles and the siding.

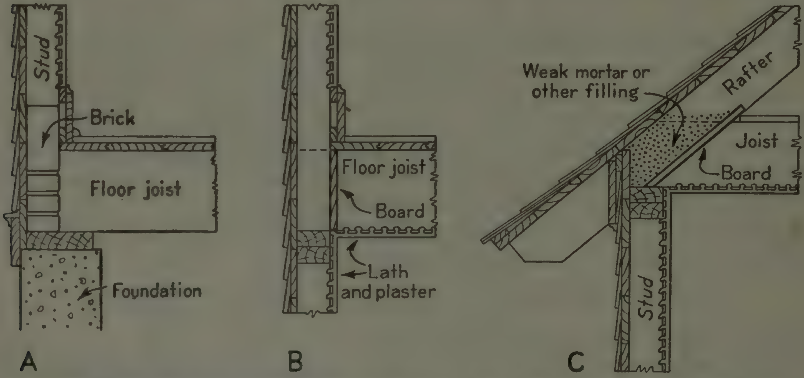


FIGURE 7.—Method of stopping drafts in walls: A, at first floor; B, at second floor; C, at attic floor

The studding of the exterior walls often form flues extending from the foundation to the upper stories. Such construction permits heat in the cellar to rise to the attic and escape through cracks at the eaves or in the roof, or cold air from outside to circulate in the walls, chilling them or passing into the rooms. Cold walls cause moisture to condense, spoiling the wall finish and creating other nuisances. Figure 7 illustrates how blocking may be used in the walls to prevent the flow of air through these flues. In new construction the spaces at the ends of second-floor joists should be blocked.[10] The blocking at first and attic floors may be placed in old houses.

Condensation of moisture on the inner surfaces of thin masonry walls can be prevented by the use of lath and plaster or wall board, separated from the masonry by wooden or metal furring strips. The air space provided by such construction results in a warm dry wall.

Single floors are likely to be cold if the building is supported on piers or if the cellar is not heated. Double floors with paper between the subflooring and the finished floor are very desirable. When houses are supported on piers, boards are often placed to the height of the first floor and banked in winter with earth or forage. It is, of course, better to build a full inclosing wall.

---

[10] Farmers' Bulletin 1590, Fire-Protective Construction on the Farm, illustrates methods of blocking fire channels. Fire stops are also effective in reducing air currents.

Much heat may be lost through an open fireplace. A damper should be provided to close off the chimney in cold weather if there is no fire on the hearth. At other times the fireplace may be utilized to provide ventilation.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	Arthur M. Hyde.
Assistant Secretary	R. W. Dunlap.
Director of Scientific Work	A. F. Woods.
Director of Regulatory Work	Walter G. Campbell.
Director of Extension Work	C. W. Warburton.
Director of Personnel and Business Administration.	W. W. Stockberger.
Director of Information	M. S. Eisenhower.
Solicitor	E. L. Marshall.
Bureau of Agricultural Economics	Nils A. Olsen, *Chief.*
Bureau of Agricultural Engineering	S. H. McCrory, *Chief.*
Bureau of Animal Industry	John R. Mohler, *Chief.*
Bureau of Biological Survey	Paul G. Redington, *Chief.*
Bureau of Chemistry and Soils	H. G. Knight, *Chief.*
Office of Cooperative Extension Work	C. B. Smith, *Chief.*
Bureau of Dairy Industry	O. E. Reed, *Chief.*
Bureau of Entomology	C. L. Marlatt, *Chief.*
Office of Experiment Stations	James T. Jardine, *Chief.*
Food and Drug Administration	Walter G. Campbell, *Director of Regulatory Work, in Charge.*
Forest Service	R. Y. Stuart, *Chief.*
Grain Futures Administration	J. W. T. Duvel, *Chief.*
Bureau of Home Economics	Louise Stanley, *Chief.*
Library	Claribel R. Barnett, *Librarian.*
Bureau of Plant Industry	William A. Taylor, *Chief.*
Bureau of Plant Quarantine	Lee A. Strong, *Chief.*
Bureau of Public Roads	Thomas H. MacDonald, *Chief.*
Weather Bureau	Charles F. Marvin, *Chief.*

U. S. GOVERNMENT PRINTING OFFICE: 1933

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

superseded by Bulletin

U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1699

GROWING ROOT CROPS FOR LIVESTOCK

ROOT CROPS most generally grown for feeding livestock include mangels, rutabagas, turnips, and carrots. They have not been extensively grown in the United States for this purpose chiefly because of the large amount of hand labor involved, and because succulent feed can be produced more cheaply as corn silage.

Root crops require a cool, moist climate for their best development, and under such conditions they may sometimes be grown to better advantage than corn. A well-prepared seed bed and an abundance of available plant food are essential to large yields. The time, rate, and method of seeding varies with the crop and with local conditions. Thorough cultivation and thinning are essential to normal root development and involve considerable hand labor.

Roots should be harvested before severe frost and stored in cellars or pits.

Mangels, rutabagas, turnips, and carrots do not differ greatly in composition, all having more water and less protein, fat, and carbohydrates than corn silage. They are chiefly valuable as a source of succulence and as appetizers and are highly prized by breeders and exhibitors of purebred stock. Roots are sometimes fed whole, but when large they should generally be cut. They are especially valuable for cows being milked. Ordinarily the limit in feeding is 3 to 5 pounds per 100 pounds of live weight, and the usual amount fed is generally not more than one-half this quantity. Excessive feeding may cause indigestion.

Under favorable conditions mangels, rutabagas, and turnips yield 20 to 30 tons per acre. The usual tonnage obtained from carrots under similar conditions is about one-half this amount.

Washington, D. C. Issued March, 1933

GROWING ROOT CROPS FOR LIVESTOCK

By H. L. Westover, *Senior Agronomist*, and H. A. Schoth, *Associate Agronomist, Division of Forage Crops and Diseases, Bureau of Plant Industry*, and A. T. Semple, *Associate Animal Husbandman, Animal Husbandry Division, Bureau of Animal Industry*

CONTENTS

Page
Soil and climatic relations 1
Varieties 2
Growing the crop 3
  Preparing the seed bed 3
  Fertilizing and liming 3
  Time of seeding 4
  Rate of seeding 4
  Method of seeding 4
  Cultivation 5
  Thinning 5
Harvesting 6
Storing 6

Page
Composition 7
Feeding 7
  Preparation of roots for feeding 8
  Root crops for cattle 9
  Root crops for sheep 9
  Root crops for horses 10
  Root crops for hogs 10
  Root crops for poultry 10
Cost of production 11
Yields 11
Insect pests 11
Diseases 12

ROOT CROPS as feed for livestock and poultry have attracted relatively little attention in the United States. One of the principal reasons for this is the amount of hand labor required in producing such a crop. In the greater part of the United States corn will produce a larger tonnage of succulence in the form of silage than can be obtained from root crops, and the silage usually can be produced much more cheaply, since it requires comparatively little hand labor. In certain sections, however, where soil and climatic conditions are especially favorable to root crops, a much greater tonnage can be obtained from them than from corn. Under such conditions root crops are worthy of consideration as sources of succulence, especially during the winter months, when little or no green feed is available. Furthermore, for the farmer who does not keep enough livestock to justify the use of a silo, root crops may advantageously supply the succulence needed for winter feeding.

The discussion of root crops in the bulletin is confined to mangels (mangel-wurzel, mangolds or stock beets, a large-growing type of beet of the species *Beta vulgaris* L.), rutabagas or swedes (*Brassica campestris* L.), turnips (*B. rapa* L.), and carrots (*Daucus carota* L.); crops that are most generally grown for the specific purpose of feeding livestock, although under certain conditions other root crops are utilized rather extensively for the same purpose.

SOIL AND CLIMATIC RELATIONS

A cool, moist climate is the most favorable for root crops, although some remarkably satisfactory yields have been obtained under dry-farming conditions in the northern Great Plains where proper attention has been given to soil preparation and plant spacing so that the competition for moisture is not too great. (Fig. 1.) In general, a deep, fertile loam is best, although fairly good crops have been produced on soils ranging in texture from a sandy loam to clay. A soil good for corn is generally satisfactory for root crops. Nearly ideal soil conditions are found on some of the diked lands and beaver-dam lands of the Pacific Northwest. These soils are usually well supplied with organic matter, are friable, and generally productive. These characteristics, together with the cool summer weather, present excellent conditions for root-crop production, and as a result some remarkable yields have been obtained. The soil and climatic conditions in parts of Minnesota, Michigan, Wisconsin, New York, and the New England States are also particularly well suited to root crops.

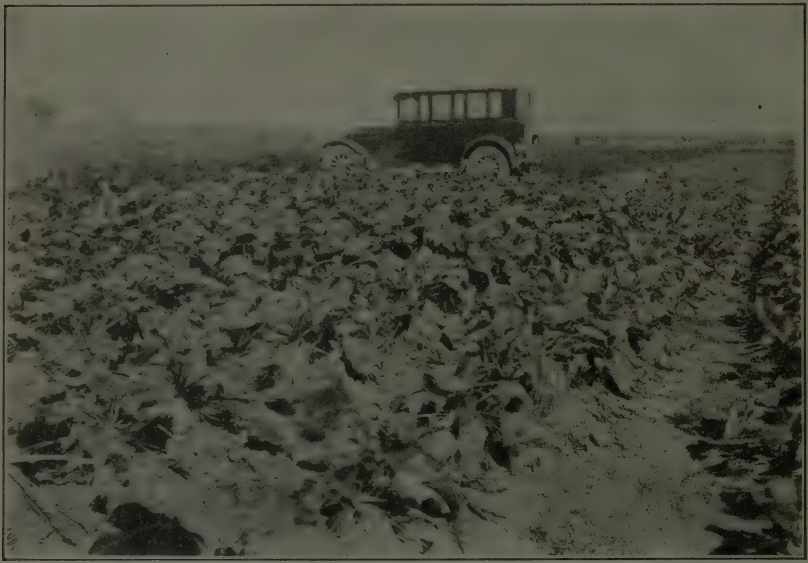


FIGURE 1.—Satisfactory yields of mangels obtained at Redfield, S. Dak., under favorable moisture conditions

VARIETIES

There are many varieties of mangels, rutabagas, turnips, and carrots, the four classes of roots most commonly grown for feeding livestock.

The Mammoth Long Red variety is probably the most popular mangel and has generally given the highest yields, especially on deep soils. The illustration on the cover page shows this variety grown at Redfield, S. Dak., in 1920, a favorable season. For shallow soils some of the shorter-rooted varieties are preferable. Other common varieties include Giant Half Sugar, Red Intermediate, Golden Tankard, Danish Sludstrup, Giant Red Eckendorf, and Heavy Cropper, the last mentioned being grown under various local names of which Giant Gatepost is most common. The most popular varieties of rutabagas are the American Purple Top, Improved Purple Top, White Sweet Russian, Carter hardy swede, Bangholm, and Hurst Monarch. Among the common varieties of turnip are Purple Top White Globe, and Cowhorn. Other varieties popular in the Pacific Northwest are Hardy Green Round, White Pomeranian, White Top Aberdeen, and Green Top Aberdeen. Bortfield and Centenary, comparatively new varieties for this region, are promising sorts and are fairly resistant to attacks of root maggots and aphids, insects that sometimes cause considerable damage to turnips and rutabagas. The most popular varieties of carrots include White Belgian, the standard white short, and the yellow-fleshed varieties, Improved Long Orange, Mastodon, Ox-heart, Chantenay, Danvers, and Giant Yellow.

The White Belgian is sometimes objected to in the Pacific Northwest because of its tendency to root so deeply on loose soils that it is harvested with difficulty. In this region the half-long types are preferred where the crop is to be harvested and stored, but where hogs or sheep are to harvest the roots, the Ox-heart variety is most popular as it is easy to remove from the soil.

GROWING THE CROP

PREPARING THE SEED BED

Soil preparation varies with local conditions. In most cases, plowing the land in the fall gives a seed bed more favorable to root crops. The following spring, as soon as the soil is sufficiently dry, it should be disked thoroughly and harrowed to insure a firm, fine, weed-free seed bed 5 to 6 inches deep. If the soil is heavy it may be necessary to plow the land again in the spring. Such soils should not be too finely pulverized, as they are likely to crust after rains. If the preparation is delayed until spring, the land should be plowed as early as possible and thoroughly disked and harrowed to encourage the germination of the weeds, which may then be destroyed before the root crop is sown. Sandy soils may require compacting with a cultipacker or ordinary roller.

FERTILIZING AND LIMING

An abundance of available plant food is essential to large yields. Some of the relatively new lands in the northern Great Plains, especially where dry farming is practiced, seem to have sufficient available plant food for root crops, but in most other parts of the United States increased yields amply justify liberal fertilizing. Experience has shown that in most cases nothing is superior to good barnyard manure applied at the rate of 10 to 20 tons per acre, either to a preceding crop or else turned under in the fall. Fine, well-rotted manure may be applied early in the spring and mixed with the soil by disking; but coarse strawy manure applied at this time causes excessive drying out of the soil and may interfere with the cultivation of the young seedlings.

Where manure is not available a 4–16–4 or a 4–16–8 commercial fertilizer should be applied at the rate of 400 to 700 pounds per acre just before seeding. In the Pacific Northwest superphosphate alone applied at the rate of 350 to 400 pounds per acre has given excellent results. Some growers in this region use well-rotted barnyard manure at the rate of 20 tons per acre, supplementing it with

300 to 400 pounds of superphosphate. On many soils one or two applications of commercial fertilizer after the roots are started will be justified by the increased yields.

Acid soils should be limed before sowing root crops, the amount required varying, of course, with the soil and previous treatment. Soils of average acidity will require about 2 tons of ground limestone or its equivalent in some other form applied to some preceding crop. Land on which alfalfa has been grown successfully will not require additional applications of lime for root crops.

TIME OF SEEDING

Mangels and carrots require a full growing season and should be sown as soon as danger of frost is past. This time will of course differ in different parts of the United States but will usually be a little earlier than corn-planting time. In the extreme North the earliest date at which root crops may be safely sown will be about May 1; southward the date will be progressively earlier. Rutabagas and turnips do not require so long a growing season as mangels and carrots and being less sensitive to cold will continue to grow later in the fall.

The time of sowing rutabagas and turnips will depend on the time at which they are desired for feeding. If early fall feed is wanted, the seed should be sown early, and if the roots are wanted for late feeding or storage for winter feed, they may be sown as late as June 15 in the Northern States and as late as July or August farther south. In some sections early seedlings are injured by root maggots and aphids, but such damage is seldom serious where seeding is delayed until June 15 or later.

In the extreme South and along the Pacific coast of Oregon and Washington rutabagas and turnips are sometimes sown in the fall and continue their growth more or less throughout the winter. Carrots are usually sown after the soil becomes sufficiently warm to insure rapid germination. Under dry-farming conditions early spring seeding of all root crops is essential, since the summer moisture is generally deficient and yields are likely to be unsatisfactory unless the plants are started early enough to get the full benefit of the spring moisture.

RATE OF SEEDING

The rate of seeding depends on whether the seed is sown broadcast or in rows, and on the distance between rows. When sown in drills 30 to 36 inches apart the seeding rates recommended for the various root crops are approximately as follows: Mangels, 6 to 8 pounds; carrots 1½ to 2 pounds; rutabagas and turnips, 1 pound per acre; when sown broadcast, the rate of seeding turnips should be 4 to 5 pounds per acre. As the seed of mangels quite often does not germinate readily and as the seedlings sometimes have difficulty in pushing through the soil, a liberal seeding rate usually pays.

METHOD OF SEEDING

The best yields are secured when root crops are sown in cultivated rows. Where the acreage is large, the rows should be at least

24 to 36 inches apart to permit the use of 1-horse cultivators. Where the ordinary corn cultivator is to be used, the rows should be 36 to 42 inches apart. In the case of small acreages that are to be cultivated with a hand cultivator, the rows may be 18 to 24 inches apart. Where the moisture supply is limited, as in the northern Great Plains, a better root development results if the rows are 36 to 42 inches apart. Carrots do not require as much space between the rows as do mangels. When sown in the fall or on stump land that is difficult to cultivate, the seed of turnips and rutabagas is usually broadcast.

In some cases turnips and rutabagas are sown broadcast at the last cultivation of another crop such as corn or potatoes, but the yields are considerably less than when they are sown alone. Occasionally turnips are sown with oats, and after the oats have been harvested the turnips furnish considerable feed if moisture conditions are favorable.

Small acreages may be sown with a hand seeder or 1-horse drill. On well-prepared land one person can sow 2 or 3 acres a day with a hand seeder, the rows being 30 inches apart. In sowing larger acreages the small types of grain drills are satisfactory if the flow of the seed is properly regulated. Whatever method is used the seed should be uniformly distributed and dropped in contact with moist soil but not covered too deeply. In sandy loams mangels should be covered three-fourths inch and in clay soils one-half inch. On similar soils carrots should be covered one-fourth to one-half inch.

CULTIVATION

Frequent and thorough cultivation to check weed growth and to maintain a loose-surface mulch are essential to success in growing root crops. The first cultivation should be given as soon as the rows can be seen. The first two cultivations should be deep and close to the row. Subsequent cultivations should be quite shallow and at intervals of two weeks until the plants are so large that cultivation without injury is no longer possible. Usually the last cultivation will be given between August 1 and 15. The hand cultivator may be used for small acreages, but for larger fields the 1-horse cultivator or the ordinary corn cultivator is used.

Where there is a thick stand it is sometimes helpful to go across the rows with a weeder soon after the plants emerge. This usually does not injure the crop to any extent but does assist materially in destroying young weeds and in breaking the surface crust. Hand weeding is usually necessary to keep the weeds out of the rows. It is evidently impractical to use tillage implements on broadcast sowings, but hand weeding is sometimes practiced.

THINNING

Proper thinning is essential to the development of normal roots and to securing satisfactory yields. When the plants have developed three or four leaves they should be blocked out with a sharp hoe, after which the thinning to single plants should be completed by hand. The most desirable distance between individual plants will vary with the soil, rainfall, and distance between rows. With optimum moisture conditions, the most desirable spacing for the various crops when grown in 30-inch rows is as follows: Mangels, 12 inches; rutabagas, 10 to 12 inches; turnips, 10 inches; carrots, 6 to 8 inches. Along the Pacific coast, carrots are seldom thinned and only about half the acreage of turnips and rutabagas is thinned.

HARVESTING

The general practice is to harvest root crops before a severe frost or when growth ceases, as indicated by the yellowing and withering of the leaves. Mangels and carrots will not stand as much cold as rutabagas and turnips and must therefore be harvested somewhat earlier. To make harvesting easier a common plow is often used to throw the soil away from one side of the row, after which the roots are easily lifted. If the acreage is considerable, the beet lifter is sometimes used to loosen the roots.

The roots are either topped as they are pulled or thrown into piles and topped later; the tops are sometimes twisted off and sometimes cut off with a sharp knife. A few growers cut the tops with a sharp hoe before the roots are lifted. After topping, two or more rows are usually thrown into a windrow and later hauled to the place of storage. Where possible the roots should be harvested on a cool, bright day when the soil is dry so that most of it will shake off before the roots are stored. As mangels and carrots bruise more easily than rutabagas and turnips, they should be handled more carefully, because badly bruised roots do not keep well in storage.

In the Pacific Northwest, turnips do not keep well in storage and are harvested as needed for feeding. Hogs and sheep are sometimes turned into the field to harvest carrots and small turnips.

STORING

Roots should be stored where they will be easily accessible during the winter, preferably in the basement of the barn where they are to be fed. Root cellars built in an excavation are less expensive than storage houses, as they do not require so much protection against freezing. The walls of an excavated cellar may be constructed of concrete at a comparatively low cost. The temperature of the cellar should never reach the freezing point and should be kept at 36° to 40° F. The ceiling and walls should be sufficiently insulated to prevent fluctuation in temperatures. Ventilating flues and slatted floors underneath the roots are necessary to provide for the escape of moist heated air and to admit fresh air. In dry climates roots to which some soil has adhered in harvesting may keep better in storage.

Although generally less satisfactory, the use of pits may be resorted to when necessary. However, extremely cold spells may interfere with feeding roots from pits. A high, well drained place should be selected for the pit. The pit should be 8 or 10 inches deep, and may be circular or long and narrow. In a circular pit the roots should be placed in a cone-shaped pile: in a long, narrow pit they should be in a long pile about 3½ feet high and 4 feet wide at the bottom. The sides of the pile should slope sufficiently to cause water to drain off rapidly from the covering. Ordinarily the piles should be covered with 3 to 6 inches of straw and then with an equal thickness of soil. The thickness of the covering, which should be sufficient to prevent freezing, will differ with climatic conditions. If the roots are to be kept well into the winter, it may be necessary to add another layer of straw and another of soil. A ventilating flue, large enough to permit the escape of damp air and to insure good air circulation, should be provided.

COMPOSITION

The average composition of the various root crops is given in Table 1. For the sake of comparison the average of several analyses of corn silage have been included in the table. It will be noted that the average composition of the various kinds of roots is very similar. Analysis of individual roots of mangels have shown a dry-matter content ranging from 7 to 14 per cent, there usually being as great difference between individuals of a variety as between varieties.

Table 1.—*Average composition and digestible nutrients of several root crops, corn silage, corn, and barley*[1]

Feed	Moisture	Ash	Crude protein	Carbohydrates		Fat, or ether extract	Digestible protein	Digestible carbohydrate equivalent
				Crude fiber	Nitrogen-free extract			
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Artichokes	78.0	1.8	2.4	0.9	16.8	0.1	1.5	16.1
Carrots	88.6	1.0	1.1	1.3	7.6	.4	.9	8.9
Mangels	91.2	1.0	1.4	.8	5.4	.2	1.1	6.4
Potatoes	78.9	1.0	2.1	.6	16.3	.1	1.3	16.3
Red beets	88.5	1.0	1.5	.9	8.0	.1	.9	8.7
Rutabagas	88.6	1.2	1.2	1.3	7.5	.2	1.0	8.5
Sugar beets	92.2	1.3	1.5	.7	4.3		.9	4.8
Sweetpotatoes	71.1	1.0	1.5	1.3	24.7	.4	.9	24.2
Turnips	90.6	.8	1.3	1.2	5.9	.2	1.2	7.4
Corn silage	70.9	1.4	2.4	6.9	17.5	.9	1.4	18.9
Barley	9.6	2.9	12.8	5.5	66.9	2.3	10.4	68.8
Corn	12.9	1.3	9.3	1.9	70.3	4.3	7.1	74.8

---

[1] The analyses and digestible nutrients of the feeds listed above have been compiled by the Miscellaneous Division, Bureau of Chemistry and Soils, and the Animal Husbandry Division, Bureau of Animal Industry, U. S. Department of Agriculture. The carbohydrate equivalent shown in the last column of the table is the sum of the digestible crude fiber and nitrogen-free extract plus 2.25 times the digestible fat.

FEEDING

In general, wherever starchy concentrates, such as corn and barley, can readily be produced at a lower cost per unit of dry matter than root crops, the value of root crops in livestock feeding is limited to the feeding of small quantities, such as 1 to 2 pounds per 100 pounds live weight daily, as a source of succulence and as an appetizer in the ration. Throughout most of the United States, corn, sorgo, and grain-sorghum silages are cheaper sources of succulence than root crops when the number of livestock is sufficient to consume 50 tons or more of silage during a period of three or four months. These limitations vary considerably with the kind of silage, type of silo, and weather conditions.

Root crops are prized by breeders of purebred stock and especially by exhibitors, as they are excellent conditioners and the roots can be stored and transported under conditions impossible with silage.

Roots should be classed as highly diluted concentrates rather than as roughages. On account of their high water content, excessive feeding may overload the digestive organs and cause indigestion. Ordinarily the limit is 3 to 5 pounds per 100 pounds live weight and not over half that amount when the roots are to be fed as a source of succulence and as an appetizer and not as an important scource of nutrients.

As a class roots are deficient in protein, fat, lime, and phosphates, and with the exception of carrots and sweetpotatoes are relatively deficient in vitamin A. As a whole, roots are a fair source of vitamins, but they do not occupy the same place in animal feeding with regard to vitamin A, calcium (lime), and iron as do the leafy, green, or yellow feeds. Carbohydrates mainly in the form of sugar are the principal nutrient, and the sugar content rises considerably during storage, as some of the starch is converted. Much of the crude fiber is in the outer skin. Being a carbonaceous feed, roots should be fed with a liberal allowance of legume hay for maintenance and a liberal allowance of grain and legume hay or grain, oil-mill by-products, and nonlegume hay for fattening. As the dry matter of roots is practically equal in nutritive value to the dry matter of grain, it takes approximately 8 to 10 pounds of roots to equal 1 pound of grain.

Experiments at the Colorado station indicate that the dry matter of roots is about one-third more valuable when fed with grains in about equal parts of dry matter than when fed without such a complement of concentrates. In fattening rations not over half of the dry matter in the concentrate should be from roots, the balance being from grain and from cereal and oil-mill by-products.

In large quantities it takes from 1½ to 2 pounds of roots to equal a pound of corn silage, on account of their higher water content: but when fed in small quantities as an appetizer a pound of roots is usually equal to a pound of silage.

When first harvested root crops have a laxative effect, which disappears to a large extent after they have been stored for a few weeks. For this reason it is advisable to delay feeding mangels until after Christmas.

PREPARATION OF ROOTS FOR FEEDING

Roots may be fed in various ways—in the field where grown, whole after storage, or cut into strips, chips, or squares by chopping boxes built for the purpose. When the roots are large, hard, and woody, old animals with poor teeth or young animals are unable to eat them satisfactorily until they have been cut. Dirt should be removed before putting them into the cutter, unless the cutter has provision for cleaning the roots before they reach the knives. Meal and chaffy roughage may be mixed with chopped roots to improve the palatability of the ration and reduce the waste.

Cooking or steaming is wasted labor and expense, because the nutritive value of the roots is decreased rather than increased by the destruction of some of the vitamins.

For poultry all roots should be fed whole, as chickens enjoy picking them.

ROOT CROPS FOR CATTLE

While it is rarely profitable in the United States to raise root crops for maintaining or fattening cattle, turnips and carrots that are too small or too inferior in quality to use or market as food can be fed to good advantage.

Where roots are as cheap a source of dry matter as grain, from 30 to 50 pounds of roots may be fed to mature cattle in a properly balanced ration. Young cattle should be fed similarly on the basis of their live weight. In some cases a 1,000-pound steer will consume a ration of 100 pounds of roots, 10 pounds of dry roughage (principally straw), and 5 to 6 pounds of concentrates, about half grain and half oil-mill by-products, for a fattening period of three to four months.

For cows giving milk, roots are especially valuable. A small quantity of roots may often improve a ration containing liberal quantities of grain, legume hay, and silage. An old belief that roots produce milk with a higher water content than do dry rations has been disproved. White Belgian carrots may be fed to cows at 35 to 45 pounds per head. Mangels are less likely to taint milk than are rutabagas and turnips. Dairy cows may be fed 40 to 60 pounds of mangels daily. Rutabagas should be fed after milking or at noon to avoid tainting the milk.

Turnips are more watery than most roots and are fed principally to cattle and sheep. As they do not keep so well as some other root crops, they should be fed in the fall. Some dairymen feed the whole turnip plant because they believe that pound for pound the tops, which often constitute about 25 per cent of the total weight, are nearly equal to the roots in nutritive value.

ROOT CROPS FOR SHEEP

In general root crops are not an economical source of nutrients for sheep. In most cases silage is a more satisfactory source of succulence. While a sheep weighing about 100 pounds may consume as much as 15 pounds of roots, 2 to 3 pounds per head furnish plenty of succulence. Therefore, where roots are to be fed, a good fattening ration consists of approximately 2 to 3 pounds of roots, 1½ pounds of hay, and 1½ pounds of grain per 100 pounds of live weight. Experiments have shown that 1 pound of corn silage is equal to approximately 1½ pounds of roots in sheep feeding.

The favorite roots for sheep are rutabagas and mangels, although White Belgian carrots may be fed to ewes at 2 to 5 pounds per head, and turnips are also fed during the fall season. Feeding mangels to rams and wethers is believed by some persons to be dangerous because it may result in the formation of calculi in the bladder and kidneys, which may cause death. While efforts to prove this by experiment have not been successful, feeders are cautioned against the liberal use of mangels to male sheep. It is also thought by some that too free use of roots previous to lambing may increase the losses of young lambs.

ROOT CROPS FOR HORSES

Roots are used principally for horses as an aid to digestion. Their extensive use in the ration is not considered economical, as they are low in nutrients, being equivalent to only about one-fourth their weight in hay. Where roots are fed, other laxative feeds should be omitted, the roughage supply decreased, and the grain ration should contain feeds high in nutrients. Large quantities of roots are particularly objectionable for horses being worked or driven hard.

Carrots rank first among root crops as a horse feed. They are exceptionally good for colts, brood mares, stallions, idle work horses, and horses that are to be exhibited. Usually the quantity fed should not exceed 10 pounds per head daily. Chopping the roots is usually advisable. Care must be taken in feeding mangels to horses to avoid digestive disturbances. If the mangels are stored for a few weeks previous to feeding, the tendency to cause scouring is considerably reduced.

ROOT CROPS FOR HOGS

Roots have little value in the ration for hogs under ordinary farm conditions when good rations of concentrates are being fed. Usually more satisfactory results have been obtained by feeding legume hay. According to the Michigan station, hogs will gather a crop of roots quite satisfactorily when they are given about one-third of a full ration of properly balanced concentrates.

While mangels, rutabagas, and carrots are considered practically equal in value for hogs, mangels are consumed with the greatest relish. Turnips are not a desirable hog feed.

In the United States and Canada wide variation in the replacement value of roots for part of the grain in swine rations has occurred in various tests. The following data give an idea of the range of values found at several stations:

Pounds of roots required to replace 100 pounds of grain in hog-feeding tests

Central Experiment Farm of Canada, Ottawa	786
Ohio Agricultural Experiment Station	642.5
Montana Agricultural Experiment Station	529
Utah Agricultural Experiment Station	455
Ontario Agricultural College	441.5
Average	570.8

There are no indications that beets, rutabagas, or turnips have an unfavorable effect on the quality of pork produced.

ROOT CROPS FOR POULTRY

Although mangels and carrots provide some succulence, they are not a satisfactory substitute for green feed for poultry. Rutabagas and turnips may be fed but are not so good as mangels or many other succulent feeds. As carrots are relatively rich in vitamins A and C they are considered the best roots for poultry.

COST OF PRODUCTION

The cost of producing root crops fluctuates from year to year and varies widely in different parts of the United States. Since much hand labor is required in producing the crop, the total cost is influenced largely by the prevailing wage and fertilizer prices. Except for harvesting and fertilizers it costs very little more to produce a good crop than a poor one; therefore, in those sections where big yields are usual, the cost of producing a ton of roots is relatively low. Rutabagas and turnips may usually be produced for 15 to 20 per cent less than mangels. Carrots are probably the most costly of the root crops commonly grown, mainly because of their smaller yields.

Because root crops compete with silage in furnishing succulence for winter feed, the relative cost of root crops and silage made from corn, vetch and oats, peas and oats, or other suitable crops should be considered. Where conditions are well suited to corn or other satisfactory silage crops there is no question that succulence in the form of silage may be produced more cheaply than succulence in the form of root crops, largely because silage production requires comparatively little hand labor. In some districts, however, with cool, moist climate especially favorable to root crops but not so well adapted to corn, the tonnage obtained from the root crops is so much greater than that of corn for silage that the production cost per ton is likely to be considerably less.

YIELDS

The yields of root crops vary with the climate, fertility of the soil, moisture supply, and other factors. As a rule, mangels produce a greater tonnage per acre than other root crops though sometimes, where the summers are short and cool and the moisture abundant, they are surpassed by rutabagas and turnips. Under favorable conditions, mangels, rutabagas, and turnips yield 20 to 40 tons per acre, while the usual tonnage obtained from carrots under similar conditions is about one-half this amount. In the northern Great Plains where the moisture supply is limited, mangels, rutabagas, and turnips yield on the average 5 to 10 tons per acre and carrots 2 to 4 tons per acre. In considering the value of root crops under dry-land conditions, the yields should be compared with those that may be obtained from other succulent crops, as corn and sunflowers, rather than with the yields obtained from roots under favorable moisture conditions. When this is done root crops show up more favorably, because they frequently give a greater tonnage than silage corn.

INSECT PESTS[1]

Mangels and carrots are seldom seriously damaged by insects, although occasionally cutworms destroy a stand to such an extent as to necesssitate reseeding. Grasshoppers, aphids, flea beetles, cabbage worms, and root maggots are sometimes quite destructive. While the usual methods for controlling such insects as pests of garden crops are rather expensive, nevertheless the information that is available on the biology and control of these insects can often be adapted to their control as pests of root crops. Damage can usually be reduced by crop rotation, clean farming, and seeding at a time when insects are least likely to be prevalent in destructive numbers.

---

[1] Contributed by the Bureau of Entomology.

When severe injury is observed and information is desired, specimens of the insect causing the damage, together with a sample of the injured plant, should be sent either to the State experiment station or the Bureau of Entomology, United States Department of Agriculture, Washington, D. C.

DISEASES

Root crops in general are comparatively free from very destructive diseases. Mangels are sometimes attacked by dry rot, but this disease usually does not cause serious damage. A bacterial rot is sometimes quite destructive in turnips. Rutabagas and carrots seldom suffer seriously from disease attacks. When diseases appear, however, rotation of crops is the most practical means of control. Turnips are likely to decay rapidly in storage, but under suitable storage conditions decay losses are not usually serious with carrots, rutabagas, and mangels.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

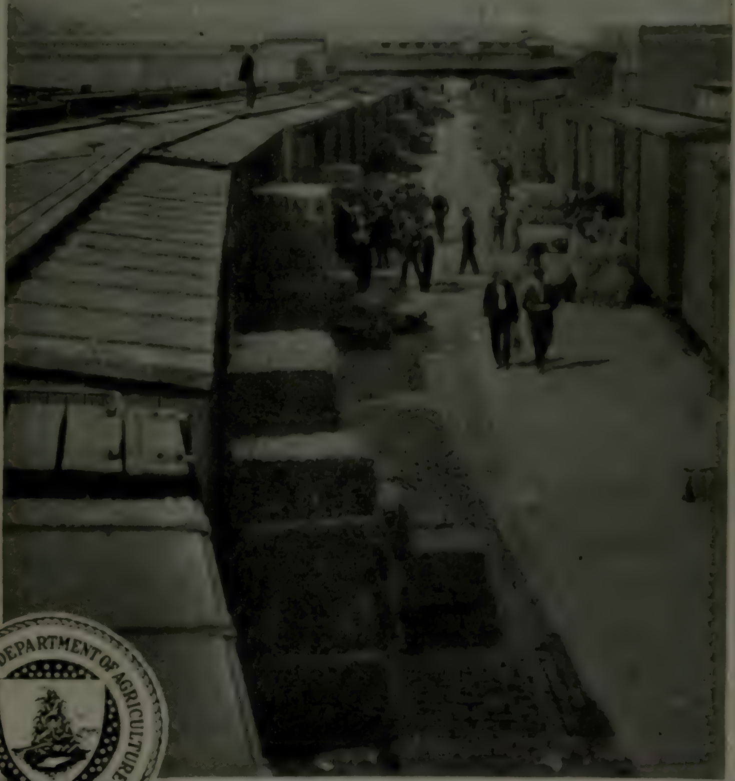
Secretary of Agriculture	HENRY A. WALLACE.
Assistant Secretary	REXFORD G. TUGWELL.
Director of Scientific Work	A. F. WOODS.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel and Business Administration.	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Solicitor	E. L. MARSHALL.
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Chief.*
Forest Service	R. Y. STUART, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Bureau of Plant Quarantine	LEE A. STRONG, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Weather Bureau	CHARLES F. MARVIN, *Chief.*

U. S. GOVERNMENT PRINTING OFFICE: 1933

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1700

MARKETING HAY BY MODERN METHODS



TEN MARKETING SUGGESTIONS FOR HAY SHIPPERS

(1) CHOOSE the method best suited to your particular needs and use sound business practices.
(2) When consigning hay select markets that have a broad, steady demand.
(3) Choose responsible commission merchants to handle your hay at terminal markets.
(4) When selling directly to wholesalers or consumers make certain of the buyer's financial responsibility and reliability.
(5) Consult available market reports about location of supplies, deficit areas, and current prices in deciding where and when to sell hay.
(6) Avoid indefinite terms and careless methods when offering hay for sale.
(7) Send buyer a written confirmation of sale, stating all terms clearly.
(8) Follow buyer's billing instructions closely.
(9) Prepare invoices carefully and forward them promptly.
(10) Keep complete records to provide adequate proof of loss or damage when claims must be made.

This bulletin supersedes Farmers' Bulletin 1265, Business Methods of Marketing Hay.

Washington, D. C. Issued April, 1933

MARKETING HAY BY MODERN METHODS

By G. A. Collier, *Senior Marketing Specialist, Division of Hay, Feed, and Seed, Bureau of Agricultural Economics*

CONTENTS

Page
Methods of marketing 1
    Consignment method 1
    Straight-sale method 4
Trade rules 5
    Statement of terms 5
    Confirmation letter 8
    Living up to the terms 8
When and where to sell 11
Using market reports 13
Making the shipment 15
    Preparing bills of lading 15
    Forwarding bills of lading 17
    Using sight and arrival drafts 18
    Making the invoice 23
    Rebilling cars 23
Loss and damage claims 24
    Preparation of shippers' claims 24

MODERN BUSINESS methods are as essential in selling and shipping hay as in any other business, and growers and shippers should adopt efficient and proved methods in marketing their hay. Success depends largely upon the shippers' knowledge of the character of hay in best demand at the various markets, and the methods of sale, weighing and inspection prevailing at different points, and upon a definite understanding of all terms and conditions of each transaction. This bulletin describes the principal methods of marketing hay, explains the most commonly used trade terms, and suggests certain marketing aids to hay growers and shippers.

METHODS OF MARKETING

There are two important methods of marketing hay—the consignment method and the straight-sales method. The consignment method consists in shipping to a broker or commission merchant who will act as the shipper's representative in selling the hay in the market in which he is located; usually the representative sells at the price prevailing when the hay arrives. Under the straight-sales method a shipper sells his hay at a fixed price, either at loading point or at destination, for shipment or for delivery at or within a specified time upon certain designated terms.

Neither of these methods is the better one to use at all times. The one that is the more advantageous one week may be less profitable the next week. It is to a shipper's advantage to learn in advance as much as possible about the merits of each, and then to obtain all the good current information that will help him to decide for each shipment which method to use.

CONSIGNMENT METHOD

SELECTING A MARKET

Selecting a market to which to consign hay, and choosing a marketing agency there, are among the most important problems in marketing. Distance to market, character of demand, preference for certain kinds of hay and certain types of bales, methods of weighing and grading, methods of sale, and the integrity and financial responsibility of dealers, must all be considered if the most profitable returns are to be obtained.

Distance to the various markets is first to be considered. Other things being equal, the market to which the lowest freight rate applies should be chosen. Other things are not always equal, however, and some may be so important as to outweigh the higher freight charge to a more distant market.

Usually it is the best policy to consign only to those markets that have a broad, general demand sufficient to absorb large quantities of different kinds and grades of hay. Although advantageous sales can frequently be made at the smaller markets, the current demand for spot hay in these markets is generally so small that a few cars of consigned hay may mean a glut. Even the larger markets can normally handle only a certain quantity of hay without seriously depressing the price. Points that have storage warehouses are likely to have a steadier market than those that depend upon irregular daily arrivals of hay.

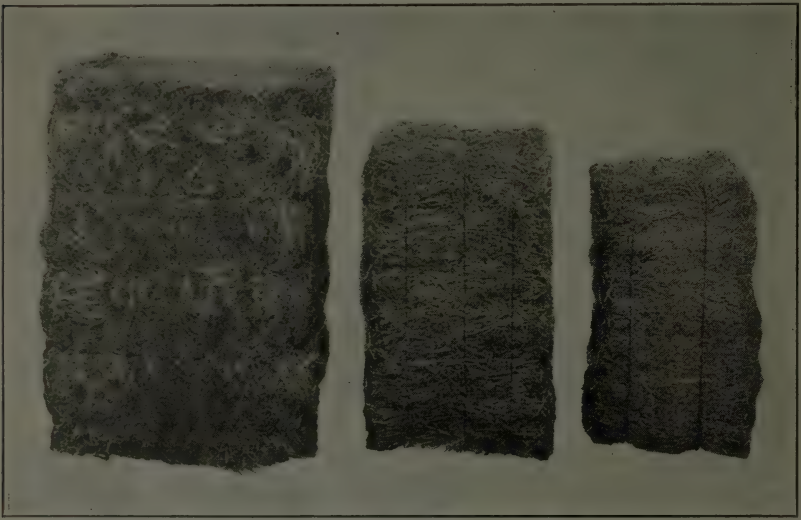


FIGURE 1.—Relative sizes of the large 5-wire, the 17 by 22 inch, and the 14 by 16 inch bales

Shippers should pay especial attention to the size and weight of bales preferred in any given market and should cater to that preference when making consigned shipments to it. Hay in bales of undesired size or weight is usually discounted by the buyers. Preferences differ in the different markets, so the type of bale that brings a premium in one market may be severely discounted in another. It is the buyer's preference rather than the shipper's that prevails.

In general, New England and other eastern markets prefer large 5 or 6 wire bales weighing from 175 to 215 pounds. Southeastern, southern, and southwestern markets prefer small 2 or 3 wire bales weighing from 75 to 100 pounds and ranging in size from 14 by 16 inches to 17 by 22 inches by about 36 to 48 inches in length. In the central-western markets the 14 by 16 inch and the 17 by 22 inch bale are both generally used. On the Pacific coast, the medium-sized 3-wire bale is preferred in the Portland, Seattle, and Los Angeles trade areas, but the large 5-wire bale is given preference at San Francisco. (Fig. 1.)

Since weighing and inspection fees are usually charged to the shipper, he is directly interested in the method employed and in the degree of economy with which these services are administered. The shipper should insist that only accurate weighing methods which will furnish correct weights be used and that enough information be taken to provide bases for proper claims in case of loss. If charges are made for the weighing service, the shipper should demand official weight certificates that state the number of bales unloaded and the total weight of the hay.

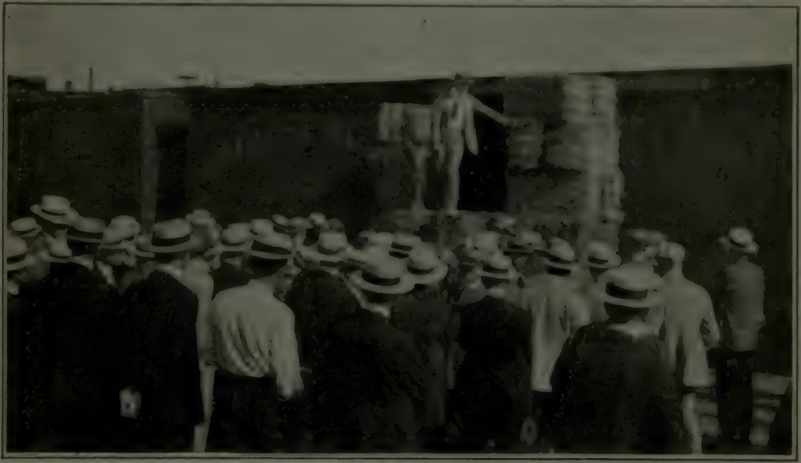


FIGURE 2. Selling hay by the "plug" method

The shipper is entitled to an official inspection certificate if a Federal, State, or trade inspection service is maintained at a market. The certificate should state the grade or grades and the quantity of hay covered by each grade designation. If an entire car is not inspected the certificate should state just what part has been inspected and graded. Charges should be based upon the services rendered and should not include other operating expenses of the market.

There are almost as many methods of selling hay as there are markets, but three, the "warehouse," "car-door," and "plug" methods are in most general use. The warehouse method consists in selling the hay at railroad or public warehouses after it has been unloaded from cars. The car-door method is employed where hay is sold from the track in railroad yards, the sale being made at the car door. "Plug" sales are made in special railroad yards from a sample, or plug, consisting usually of 20 to 30 bales which have been removed from the car and piled on the ground or on a platform beside the car. (Fig. 2.)

Each method has its advantages and disadvantages. Each shipper should know which one is used in the market to which he is shipping and what service is rendered for the charges assessed. He can then determine which method is best suited to his particular marketing problem.

CHOOSING A COMMISSION MERCHANT

Profitable returns from consignments depend to a great extent upon the ability and reliability of the shipper's representative at the market. Only those representatives who can demonstrate their ability as conscientious and trained salesmen and their knowledge of the needs of the market and the responsibility and financial standing of the buyers should be employed. Their services may entail a relatively high first cost but will probably be economical in the end.

Where trade organizations or exchanges exist, membership (which requires certain desirable qualifications) is some indication of reliability, but there are many reliable men outside of such organizations who will render efficient service. Before making consignments, shippers should obtain from banks or commercial-rating agencies satisfactory recommendations concerning commission merchants to whom they expect to entrust the marketing of their hay.

STRAIGHT-SALE METHOD

The producer or shipper who prefers not to consign his hay can usually sell it outright at some available market. There are also dealers in consuming sections or shippers and track buyers at convenient points in producing areas who will almost always buy at current market prices.

HOW TO SELECT BUYERS

In the larger markets, lists of responsible dealers or buyers can usually be obtained from trade organizations such as chambers of commerce, hay exchanges, and boards of trade. Such organizations usually do not guarantee the reliability of the firms or individuals whose names they furnish, but the fact of membership is of some importance.

In smaller markets and at interior consuming points it is more difficult to obtain the names of hay buyers. However, many railroads have for free distribution lists of dealers in agricultural commodities located on their lines; State and national hay-trade organizations will usually furnish lists of their members in the various States; and trade journals frequently have similar lists for sale at nominal prices. State and Federal departments of agriculture will furnish a limited number of names from lists on file in their marketing divisions.

Usually these agencies do not guarantee the reliability of the buyers whose names they furnish, nor do they take any further responsibility; therefore, a shipper should make further inquiry about a prospective customer's financial rating and business integrity. Generally the local banker will obtain this information if the shipper does not have access to records of commercial-rating agencies. Shippers should beware of those buyers who depart to any great extent from sound and conservative business methods.

HOLDING THE TRADE

Holding the trade of desirable customers is important to the shipper and is not so expensive as obtaining new customers. A clear understanding of the terms of sale (including quality and quantity of hay sold, time of shipment, and settlement terms) is probably the most important factor in mutually satisfactory trade relations. The shipper must furnish the quality of hay wanted by the buyer and specified in the terms of sale.

The spirit as well as the letter of the contract should be observed. For instance, a rise in the market price between time of sale and time of shipment should not cause the shipper to furnish a lower quality of hay than is called for in the contract; a decline in the market after a sale has been made should not cause the shipper to load cars to their maximum capacity when he is aware that the buyer wants only small or medium-sized carloads. When arrival-draft terms are specified, sight drafts should not be made.

TRADE RULES

More care in making clear the terms of the transaction and in making certain that both buyer and seller have the same understanding of these terms, would prevent many of the difficulties between shippers and buyers which sometimes result in severing business relations.

There are a few general and practical rules which, if followed, will tend to eliminate many misunderstandings between buyers and sellers. These are:

(1) When buying or selling hay, offering hay for sale, or bidding for hay, all contingent terms should be clearly stated. These include quantity; quality, as expressed by class and grade; place of inspection or point at which grades apply; time of shipment or delivery; routing; the price and where, or when, it applies; and terms of payment.

(2) All trades should be confirmed the same day by letter. Confirmation should state clearly all terms and conditions pertaining to the sale or purchase. Any apparent discrepancy between the confirmation and the understanding of either the buyer or the seller as to the terms upon which the trade was made should immediately be corrected by telegraph or telephone before shipment is made, if possible.

(3) Reliability and financial responsibility of the other party to the transaction should be ascertained by both the seller and the purchaser.

STATEMENT OF TERMS

Great care should be taken in stating terms when making bids and offers or when buying or selling. The extensive use of telephone or telegraph in such transactions makes brevity necessary but a few cents more spent to make telegrams or telephone messages clear and definite will yield good returns. The important items or terms should be included in bids or offers and in purchase or sale contracts, whether made by telegraph, telephone, or letter.

QUANTITY

Quantity may be stated in car lots, tons, or bales. In many instances the size and type of bale should be specified, as some buyers have decided preferences.

QUALITY

The use of descriptive terms as quality specifications, is generally unsatisfactory because of the different interpretations placed upon such descriptions. A definite standard expressed by class and grade is much better. Such a standard for the various kinds of hay is provided through the United States grades for timothy, clover, alfalfa, prairie, Johnson grass, grain hay, soybean hay, and grass hays and their mixtures. United States standards for timothy and clover are specific as to the various factors that determine the class and quality of these hays, including mixture, color, and foreign material. The grade specifications for alfalfa include definite limitations for leafiness and are so arranged that buyers can indicate, by grade designation alone, their preference as to leafiness and color. The Federal grades for other kinds of market hay are equally definite and comprehensive and provide a satisfactory basis for trading, particularly between buyers and sellers who are located some distance apart. Full information on the United States grades can be obtained from the Bureau of Agricultural Economics, United States Department of Agriculture.

State or commercial grades are used as official grades for some markets that have not yet adopted Federal standards. These State or commercial grades, although usually less definite than those formulated by the United States Department of Agriculture, provide a much better trading basis than do descriptive terms of quality; they should be used when for any reason the use of Federal grades is not practicable, but there should always be a definite understanding between buyer and seller as to the standards or grades upon which any transaction is based.

INSPECTION

It is essential that both seller and buyer clearly understand when, where, and how the hay is to be inspected. If hay is offered and sold on shipping-point inspection, and if the grades determined by such inspection are to apply, the shipper should so state in his offer or terms of sale. If inspection is to be made at destination or at some market en route where inspection is available, the fact should be stated.

TIME OF SHIPMENT

The time at or within which shipment or delivery is to be made should be stated clearly and in definite terms (such as 5 days, 10 days, or 30 days) with a clear indication of whether the statement relates to time within which the shipment is to be made, or time within which the delivery to the buyer is to be made.

ROUTING

It is important that all shipments be routed in accordance with terms of sale or subsequent orders from buyers unless such orders are not in accord with original contract. The name of the railroad upon which shipment or delivery can be made, or is to be made, should be stated in shipper's offer of sale or buyer's bid, when possible. If, for any reason, the terms of the offer or the buyer's instructions in regard to routing or railroad delivery can not be complied with, shipment should be held until satisfactory adjustments are made.

PRICE, WHERE AND WHEN IT APPLIES

The price included in a quotation bid or offer should be stated clearly, also the unit to which it applies and the point at which it applies (that is, whether it is an f. o. b. or a "delivered" price). When making an offer of sale, the length of time for which the offer holds good should be indicated, and whether its acceptance by the buyer is subject to confirmation of the shipper.

TERMS OF PAYMENT

Unless buyer and seller, through previous correspondence or transactions, have reached a definite understanding on terms of settlement, such terms should be stated in the original articles. There should also be a definite understanding as to which party is to pay the exchange charges on drafts, the weighing and inspection charges, and other marketing costs. Sellers usually draw drafts against shipments for a part or all of the invoice price, but it is customary among buyers in some sections to pay drafts only on arrival of the hay, whereas other buyers will pay sight drafts on presentation, if accompanied with proper supporting documents, including bill of lading and weight and inspection certificates. Federal inspection certificates are the most satisfactory for this purpose as they state definitely the class and grade of the hay and are issued by an impartial agency.

SUGGESTED FORMS FOR TELEGRAMS FOR OFFERING HAY OR REQUESTING OFFERS

(The names here used are fictitious)

Offer on destination terms

STUART, NEBR., JANUARY 1, 1932.

JAMES JOHNSON,
139 NORTH CLARK STREET,
CHICAGO, ILL.

OFFER PROMPT SHIPMENT SUBJECT CONFIRMATION TWELVE TONS MEDIUM BALES U S NO TWO UPLAND FIFTEEN DOLLARS TON DELIVERED CHICAGO VIA C & Y W ARRIVAL DRAFT WEIGHTS AND FEDERAL INSPECTION CHICAGO.

(SIGNED) ROY ROBERTS.

Acceptance of offer on destination terms

CHICAGO, ILL., JANUARY 1, 1932.

ROY ROBERTS,
STUART, NEBR.

ACCEPT OFFER PROMPT SHIPMENT TWELVE TONS MEDIUM BALES U S NO TWO UPLAND FIFTEEN DOLLARS TON DELIVERED CHICAGO C & Y W ARRIVAL DRAFT WEIGHTS AND FEDERAL INSPECTION CHICAGO FINAL.

(SIGNED) JAMES JOHNSON.

Offer on shipper's terms

ARTESIA, NEW MEX., JANUARY 1, 1932.

FRANK FOSTER,
SAN ANTONIO, TEX.

OFFER SHIPMENT WITHIN FIFTEEN DAYS VIA S P FIFTY TONS SMALL BALES U S NO ONE ALFALFA TEN DOLLARS TON F O B ARTESIA SIGHT DRAFT FEDERAL INSPECTION ARTESIA CERTIFICATE ATTACHED B/L SHIPPERS WEIGHTS.

(SIGNED) WALTER WATKINS.

Offer delivered on destination terms

LANSING, MICH., JANUARY 1, 1932.

JOHN JONES,
35 PINE STREET,
ATLANTA, GA.

OFFER IMMEDIATE SHIPMENT IMMEDIATE ACCEPTANCE THREE CAPACITY CARS U S NO ONE TIMOTHY LIGHT GRASS MIXED MEDIUM BALES TWENTY DOLLARS TON ARRIVAL DRAFT DELIVERED ATLANTA VIA SOUTHERN DESTINATION WEIGHTS AND FEDERAL INSPECTION.

(SIGNED) RALPH RANKIN.

Bid to country shippers from terminal market buyers

KANSAS CITY, MO., JANUARY 1, 1932.

HENRY HANSON,
LAMAR, COLO.

OFFER FIFTEEN DOLLARS TON F O B LAMAR ANY PART TEN CARS U S NO ONE EXTRA LEAFY ALFALFA MEDIUM BALES SHIPMENT WITHIN THIRTY DAYS SHIPPERS WEIGHTS GUARANTEED FEDERAL INSPECTION KANSAS CITY ARRIVAL DRAFT SUBJECT CONFIRMATION BY WIRE.

(SIGNED) HAROLD HOWARD.

Telegrams may be shortened by using code words. In the following suggested telegram, code words as given in Robinson's telegraphic code book have been substituted for several terms in the telegram next above.

KANSAS CITY, MO., JANUARY 1, 1932.

HENRY HANSON,
LAMAR, COLO.

OFFER LIABLE MISCHANCE ANY PART AFRAID GRADATION EXTRA LEAFY ACCOMPLICE POLICE SHIPPERS WEIGHTS GUARANTEED FEDERAL INSPECTION KANSAS CITY ARRIVAL DRAFT MANAKIN.

(SIGNED) HAROLD HOWARD.

CONFIRMATION LETTER

When a bid has been accepted and a sale consummated, either by letter or wire, a confirmation letter setting forth in detail all the terms and conditions of the transaction should be mailed by each party to the other. If, upon receipt of these confirmations, either party notes any item that is contrary to his understanding of the terms, he should immediately notify the other by telegraph, so that all errors may be corrected before shipment is made. If the hay was ready for shipment when the sale was made, however, it may not be possible for the shipper to wait for a written confirmation of the acceptance of the buyer. In that case he should telegraph the buyer, confirming the terms of his original offer and his understanding of the acceptance.

LIVING UP TO THE TERMS

The seller's responsibility does not end when he has made the sale. Filling the order is a further responsibility. Hay intended for market should be sorted carefully before loading and only hay of uniform quality should be loaded in each car. This applies to hay consigned to a market, as well as to outright sales. When consigned shipments containing different qualities of hay are offered in the markets, buyers tend to base their bids on the lowest quality rather than on the highest or on the average quality of the lot.

The bales should be stored in the car in tiers and loaded from each end toward the middle, so they can be readily taken out for inspection, or unloaded, without breakage and subsequent loss. The tiers should be arranged in such a way as to utilize all the space. (Fig. 3.)

Offering "split" or mixed cars in effect narrows the demand in the market, as many buyers who can use only a certain class or grade of hay will not buy cars in which part of the hay is of a quality not suitable. When scarcity of the quality they need compels such buyers to take these split cars they usually do so only at heavy price discounts for the parts not suited to their requirements.

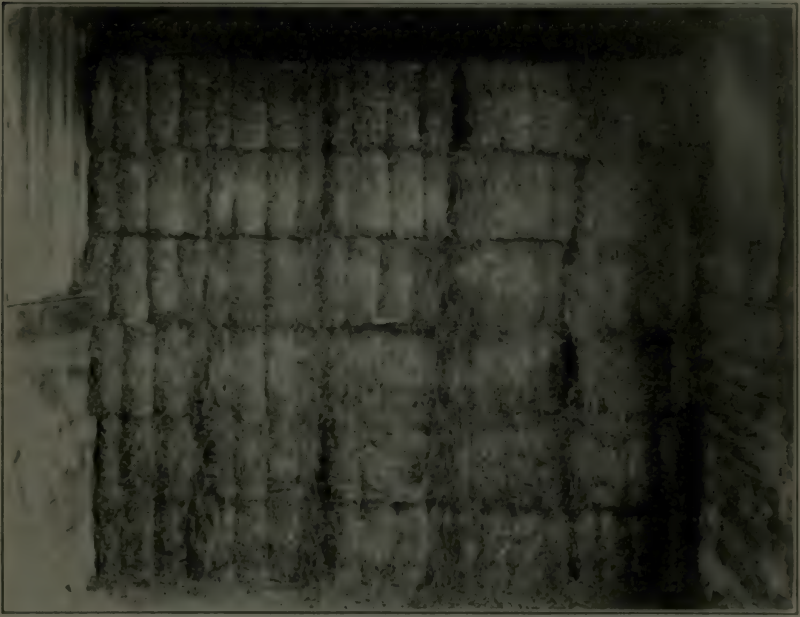
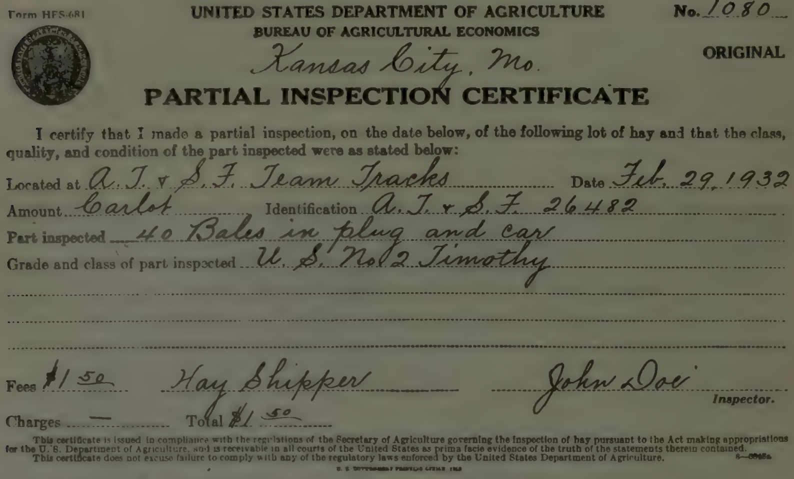


FIGURE 3.—Bales should be arranged in tiers in such a way as to utilize all the space

Shippers should load only the class and grade of hay called for in their contracts. If Federal or other inspection service is available, an inspector's certificate that will definitely indicate the class and grade of hay can be obtained. If no inspection is available at the point of shipment, shippers can readily familiarize themselves with the Federal standards by studying the Handbook of Official Hay Standards, and other information published by the United States Department of Agriculture. Information on State and commercial grades can be obtained from State inspection departments and from the trade associations. (Figs. 4 and 5 show types of Federal inspection certificates.)

When it is impossible to inspect the entire contents of a car of hay a partial inspection certificate (fig. 4) can be obtained, covering such part of the lot as can be seen by the inspector either at the car door or after the car has been "plugged." The value of the partial inspection certificate depends upon the uniformity of the quality of the hay in the car. The complete inspection certificate (fig. 5) is the most satisfactory certificate for marketing purposes, since it covers the entire lot and leaves no doubt about the quality of any part of the shipment.



Form HFS-681

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL ECONOMICS
Kansas City, Mo.

No. 1080

ORIGINAL

PARTIAL INSPECTION CERTIFICATE

I certify that I made a partial inspection, on the date below, of the following lot of hay and that the class, quality, and condition of the part inspected were as stated below:

Located at A. T. & S. F. Team Tracks Date Feb. 29, 1932

Amount Carlot Identification A. T. & S. F. 26482

Part inspected 40 Bales in plug and car

Grade and class of part inspected U. S. No. 2 Timothy

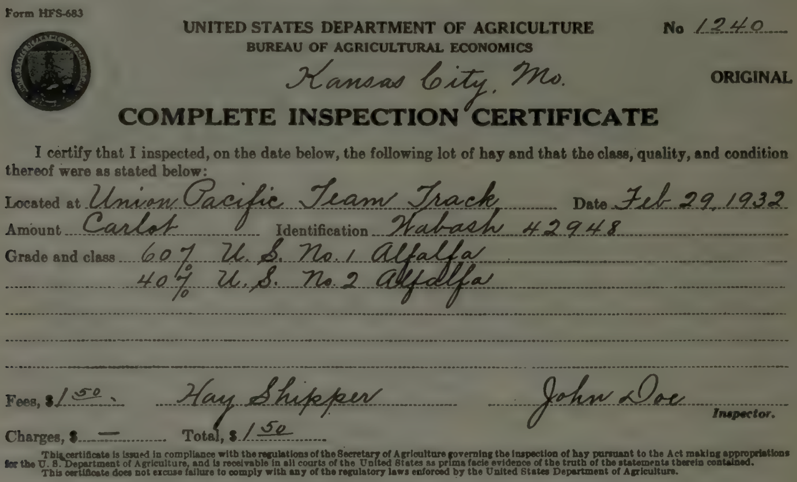
Fees $1.50 Hay Shipper John Doe, *Inspector.*

Charges — Total $1.50

This certificate is issued in compliance with the regulations of the Secretary of Agriculture governing the inspection of hay pursuant to the Act making appropriations for the U. S. Department of Agriculture, and is receivable in all courts of the United States as prima facie evidence of the truth of the statements therein contained.
This certificate does not excuse failure to comply with any of the regulatory laws enforced by the United States Department of Agriculture.

FIGURE 4.—Partial inspection certificate issued by Federal inspector

Inability of the shipper to obtain hay of the quality which he agreed to ship is not a valid excuse for shipping a lower grade in the hope that the buyer will accept it or with the expectation of making some price adjustment when the shipment arrives. Such practices almost invariably cause shippers heavy financial losses and usually mean the loss of customers. When weather conditions or other causes have lowered the quality of the hay with which a shipper had expected to fill his sales contract, or have delayed shipment beyond the time agreed upon, the shipper should advise the buyer



Form HFS-683

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL ECONOMICS
Kansas City, Mo.

No 1240

ORIGINAL

COMPLETE INSPECTION CERTIFICATE

I certify that I inspected, on the date below, the following lot of hay and that the class, quality, and condition thereof were as stated below:

Located at Union Pacific Team Track Date Feb. 29, 1932

Amount Carlot Identification Wabash 42948

Grade and class 60% U. S. No. 1 Alfalfa
40% U. S. No. 2 Alfalfa

Fees, $1.50 Hay Shipper John Doe, *Inspector.*

Charges, $ — Total, $1.50

This certificate is issued in compliance with the regulations of the Secretary of Agriculture governing the inspection of hay pursuant to the Act making appropriations for the U. S. Department of Agriculture, and is receivable in all courts of the United States as prima facie evidence of the truth of the statements therein contained.
This certificate does not excuse failure to comply with any of the regulatory laws enforced by the United States Department of Agriculture.

FIGURE 5.—Complete inspection certificate issued by Federal inspector

immediately, and seek an extension of time or such adjustment of the original contract as will enable him to fulfill it.

Buyers also assume definite responsibility when placing orders. They should not contract for more than they can handle nor demand grades of hay that are not generally available. Buyers should realize that supplies of United States No. 1 or other top grades of hay are sometimes limited. United States No. 2 hay of the various classes is good market hay suitable for many feeding requirements. Buyers should familiarize themselves with the various grades and should use definite class and grade names when ordering hay. In most instances this will insure more satisfactory quality than if the orders are by description which may be more or less indefinite.

WHEN AND WHERE TO SELL

No definite time at which a producer or shipper can sell his hay most advantageously can be set, because many factors must be considered, and some of these have different values to different shippers. Some growers bale and sell their hay as soon as it is harvested because they need funds or because they do not have proper storage facilities. Others place their hay in stacks for a short time, then bale and sell it in the late fall or early winter before it has suffered any serious weather damage. Need of money for buying winter supplies causes many growers to sell their hay about the 1st of December.

Some farmers place their hay in barns or storage sheds at harvesting time, either loose or baled, and let it remain there until they consider the market situation most favorable for disposing of it. Some growers sell just before the next season's harvest begins. Growers and shippers who bale and store their hay possess one distinct advantage in having hay available for immediate sale or shipment at times when market prices are most favorable, because storms, bad road conditions, or severely cold weather have occasioned light offerings. To profit by such conditions, shippers must have their hay stored near railroad sidings or loading points or where it is readily available to local feeders who are in urgent need.

Prices of hay are influenced by current supply and demand, but also show rather definite seasonal trends. Statistics compiled by the Bureau of Agricultural Economics show that prices for timothy and prairie hay average higher during May or June, and alfalfa prices average higher during the period from December through April. (Fig. 6.) Receipts are an important market factor, and variations in arrivals of hay (fig. 7) frequently cause sharp price changes. Hay prices are usually highest in the months just before the new crop begins to come upon the market. No definite figures on carrying costs, including interest and insurance, nor on the amount of shrinkage for which allowance must be made, are available. However, the spread in the average prices prevailing during the various months is hardly enough to warrant a general statement that April or May is always the best month in which to sell hay.

There are wide price fluctuations within periods of high prices and periods of low prices during which varying quantities of hay are sold, and often there are wide fluctuations within a single year.

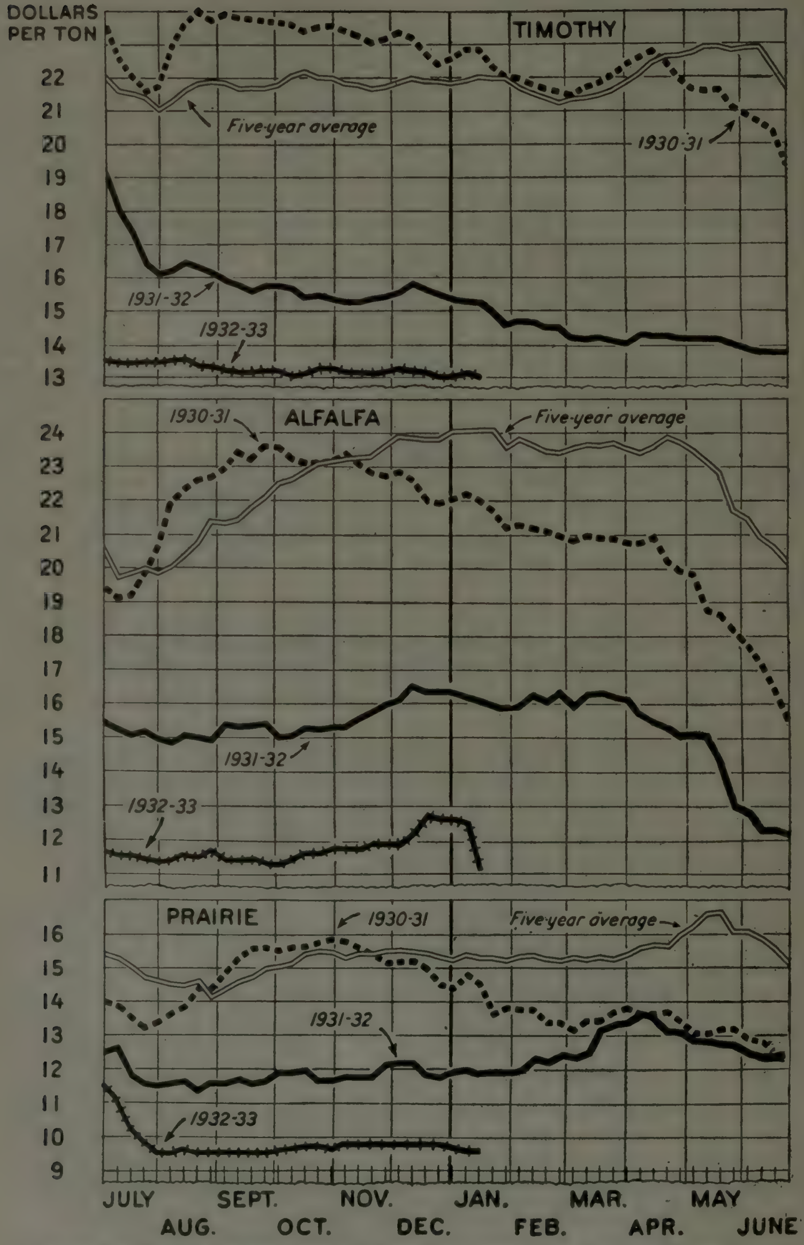


FIGURE 6.—Weekly average prices of hay at representative markets; 5-year average 1925–1929: average for 1930–31 season; average for 1931–32 season; and average for 1932–33 season

Prices may also differ at different markets within the same period, because of changing conditions of supply and demand. The producer and shipper must know these conditions in order to market their hay intelligently and to the best advantage. Knowledge of production and marketing in a single locality or market is not sufficient. Such knowledge must cover state-wide and nation-wide conditions. Through Federal and State departments of agriculture and trade organizations, such information is now available to practically any interested person.

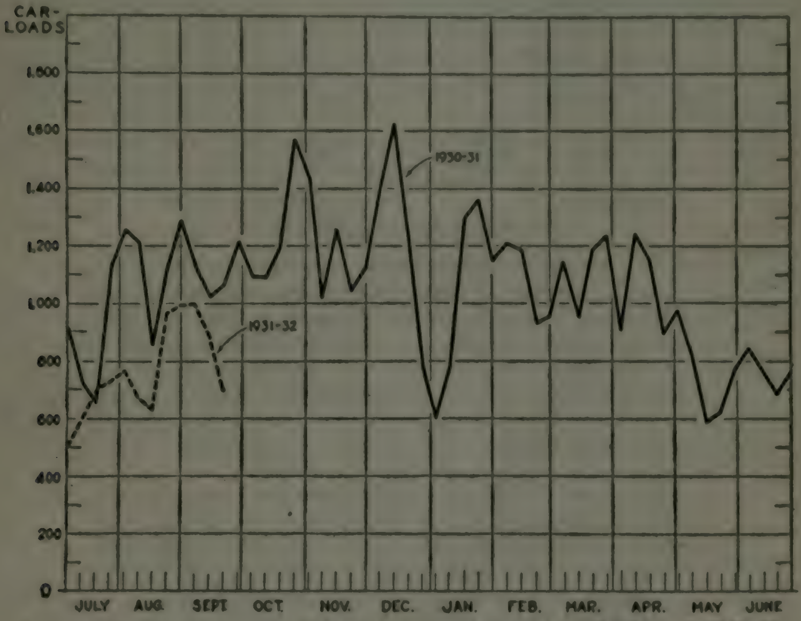
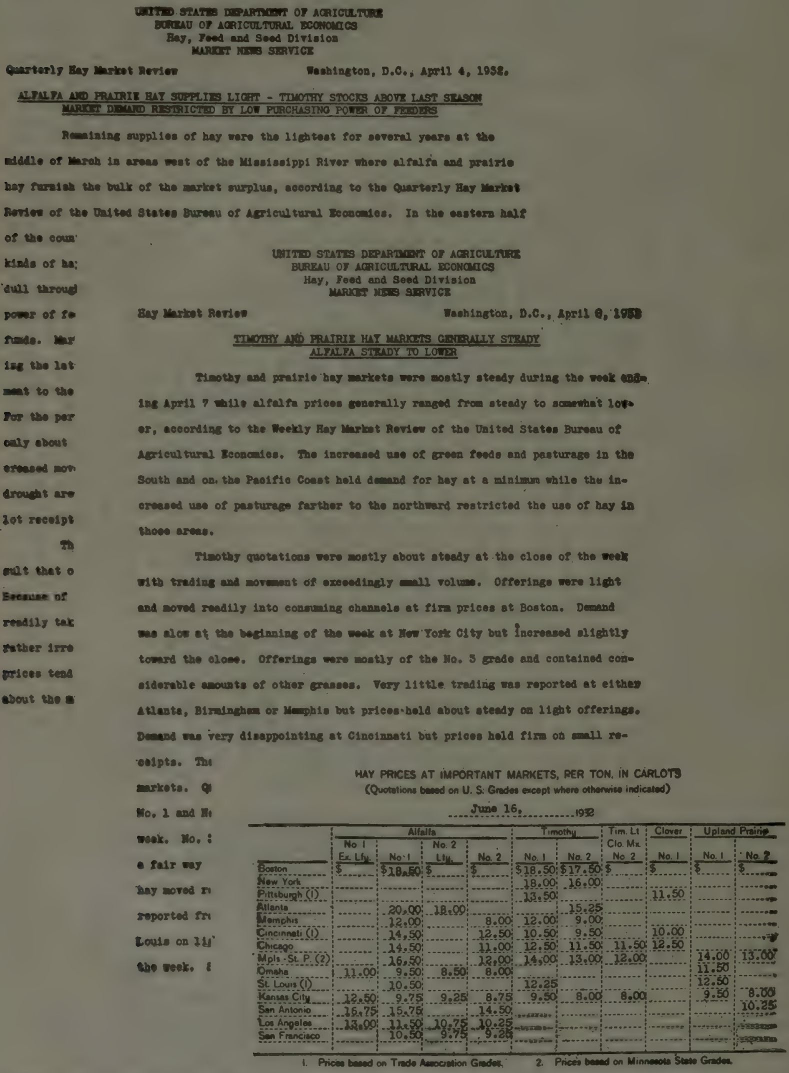


FIGURE 7.—Weekly receipts of hay at principal markets, 1930–31 and 1931–32

USING MARKET REPORTS

Trade organizations in many markets prepare daily reports containing statistics on receipts, shipments, and prices, as well as comprehensive reviews of the situation and the outlook in their particular markets. Such a report usually is available to all patrons of the market concerned, and should be used, although it applies in the main to one market only. Many State departments of agriculture issue periodical reports on the crop conditions and estimated productions of the various agricultural commodities within the State. Some of these departments, through their marketing bureaus, also issue regular market reports which deal with prices, supply, and demand, and the market situation of important agricultural products at the various markets within the State, and frequently at near-by distributing markets.

The Bureau of Agricultural Economics of the United States Department of Agriculture makes careful estimates of the production of the various classes of hay and publishes reports of these estimates regularly. Marketing specialists of the bureau, by means of regular reports from reliable and able correspondents throughout the country, study and analyze the market situation and prepare reports or reviews which are distributed by telegraph and telephone and in printed form. Many of these reports are available free of charge to those who need them. (Fig. 8.)



UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL ECONOMICS
Hay, Feed and Seed Division
MARKET NEWS SERVICE

Quarterly Hay Market Review Washington, D.C., April 4, 1932.

ALFALFA AND PRAIRIE HAY SUPPLIES LIGHT - TIMOTHY STOCKS ABOVE LAST SEASON
MARKET DEMAND RESTRICTED BY LOW PURCHASING POWER OF FEEDERS

Remaining supplies of hay were the lightest for several years at the middle of March in areas west of the Mississippi River where alfalfa and prairie hay furnish the bulk of the market surplus, according to the Quarterly Hay Market Review of the United States Bureau of Agricultural Economics. In the eastern half

of the coun
kinds of ha
dull throug
power of fe
funds. Mar
ing the lat
ment to the
For the per
only about
creased mov
drought are
lot receipt
Th
sult that o
Because of
readily tak
rather irre
prices tend
about the m

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF AGRICULTURAL ECONOMICS
Hay, Feed and Seed Division
MARKET NEWS SERVICE

Hay Market Review Washington, D.C., April 8, 1932

TIMOTHY AND PRAIRIE HAY MARKETS GENERALLY STEADY
ALFALFA STEADY TO LOWER

Timothy and prairie hay markets were mostly steady during the week ending April 7 while alfalfa prices generally ranged from steady to somewhat lower, according to the Weekly Hay Market Review of the United States Bureau of Agricultural Economics. The increased use of green feeds and pasturage in the South and on the Pacific Coast held demand for hay at a minimum while the increased use of pasturage farther to the northward restricted the use of hay in those areas.

Timothy quotations were mostly about steady at the close of the week with trading and movement of exceedingly small volume. Offerings were light and moved readily into consuming channels at firm prices at Boston. Demand was slow at the beginning of the week at New York City but increased slightly toward the close. Offerings were mostly of the No. 3 grade and contained considerable amounts of other grasses. Very little trading was reported at either Atlanta, Birmingham or Memphis but prices held about steady on light offerings. Demand was very disappointing at Cincinnati but prices held firm on small re-

ceipts. The
markets. Q
No. 1 and N
week. No.
a fair way
hay moved r
reported fr
Louis on li
the week.

HAY PRICES AT IMPORTANT MARKETS, PER TON, IN CARLOTS
(Quotations based on U. S. Grades except where otherwise indicated)

June 16, 1932

	Alfalfa				Timothy		Tim. Lt. Clo. Mx.	Clover	Upland Prairie	
	No 1 Ex. Lfy.	No 1	No. 2 Lfy.	No. 2	No. 1	No. 2	No 2	No. 1	No. 1	No. 2
Boston	$	$18.50	$	$	$18.50	$17.50	$	$	$	$
New York					18.00	16.00				
Pittsburgh (1)					13.50			11.50		
Atlanta		20.00	18.00			15.25				
Memphis		12.00		8.00	12.00	9.00				
Cincinnati (1)		14.50		12.50	10.50	9.50		10.00		
Chicago		14.50		11.00	12.50	11.50	11.50	12.50		
Mpls.-St. P. (2)		16.50		12.00	14.00	13.00	12.00		14.00	13.00
Omaha	11.00	9.50	8.50	8.00					11.50	
St. Louis (1)		10.50			12.25				12.50	
Kansas City	12.50	9.75	9.25	8.75	9.50	8.00	8.00		9.50	8.00
San Antonio	16.75	15.75		14.50						10.25
Los Angeles	13.00	11.50	10.75	10.25						
San Francisco		10.50	9.75	9.25						

1. Prices based on Trade Association Grades. 2. Prices based on Minnesota State Grades.

FIGURE 8.—Hay market reviews provide helpful information about market conditions

Production reports indicate the supply and, in many instances, also indicate probable demand. For example, a shipper, in the timothy-producing section of Michigan, knows that locally there is a large crop of hay and a large marketable surplus. Considering only the local situation, he would probably expect low prices. Upon examining the report on hay production issued by the United States

Department of Agriculture, however, he finds that there is a scarcity in the New England States, where usually there is a surplus or at least a supply sufficient for local needs. This situation immediately suggests a possible market for the Michigan surplus. Upon further study the shipper finds that there is a good local crop of hay in several of the Southern States to which he usually ships. He concludes, therefore, that his best market for this season will be in New England.

His next problem is to keep in close touch with the market situation as it develops. To do this he studies all available market reports on the situation in New England. The principal factors to be ascertained are the probable extent of the demand, supplies, and marketings in competing areas, and such other factors as weather conditions, local supplies, etc., which might influence the demand. Such information is now furnished through State and national marketing publications and through trade publications.

MAKING THE SHIPMENT

When the hay is ready for shipment it should be billed correctly and a carefully prepared invoice should immediately be forwarded to the consignee. The shipper should (1) follow in detail the billing instructions furnished by the consignee, naming route and delivery road when requested; (2) prepare the invoice carefully, giving car initial and number, date of shipment, number of bales, total weight of car, particular kind or grade of hay, and price when available; and (3) forward the bill of lading and invoice promptly.

PREPARING BILLS OF LADING

Bills of lading should show clearly the name of the person or firm to whom the hay is being shipped and the route, destination, car initial and number, kind of hay, number of bales, total weight, and name of shipper. Two kinds of uniform bills of lading are used by railroads—the "straight" bill of lading and the "order" bill of lading. The straight bill of lading is not negotiable and is simply an agreement between the shipper and the carrier, by which the latter agrees to accept, transport, and deliver the goods of the shipper to the consignee at a stated destination. Although the straight bill of lading imposes upon the carrier the same responsibility in the care of the shipment as does the order bill of lading, it does not afford the shipper equal protection, since it does not require any indorsement by the shipper and serves only to identify the consignee when he requests delivery of the goods. A hay shipper should use the straight bill of lading only when he has the greatest confidence in the integrity and financial responsibility of the consignee.

The order bill of lading is negotiable; that is, it is subject to indorsement by the shipper and others to whom the ownership may be passed by such indorsement. In addition, shipments on an order bill of lading will not be delivered to the consignee until the original bill of lading is surrendered or a bond is posted by the party to whom the shipment is billed. This requirement that the original bill of lading must be surrendered to the carrier by the consignee fully protects the shipper against irresponsible or dishonest buyers, particularly if a draft covering the value of the shipment is attached to and forwarded with the bill of lading through banking channels for collection.

A shipper who wishes to draw sight or arrival draft against his shipment and who wants to prevent a buyer from obtaining possession of the hay until payment is made for it should use an order bill of lading. It is easily distinguishable from a straight bill of lading by its color; it is yellow and the straight bill of lading is white. Another distinguishing mark is found in the words "not negotiable" which appear only on the straight bills of lading.

Although the order bill of lading protects the shipper, it can also be so drawn as to impose no hardship upon the buyer. No careful buyer is willing to accept and pay for a shipment of hay without knowing that it is of the class and quality specified in his purchase agreement. Buyers therefore usually require that they be allowed to inspect the hay upon arrival or have it inspected by Federal, State, or commercial inspection agencies. Railroads require that the notation "Inspection allowed" be clearly shown on an order bill of lading before they will allow anyone to open the car for inspection purposes. Shippers should place this notation plainly upon all order bills of lading covering shipments which have been sold subject to inspection at destination and on other shipments when buyers request the privilege of inspecting the hay before paying the draft.

If the billing instructions furnished by the consignee are not clear, it is usually better to hold the shipment until satisfactory instructions are received than to take the chance of billing it incorrectly. When specific instructions for routing or delivery are given, they should be followed exactly, for in many cases a shipment arriving over a railroad other than that specified must be switched at considerable cost before delivery can be made at the desired location. In many markets hay shipments arriving in certain railroad yards do not sell so advantageously as does hay in other yards, because of unfavorable switching facilities or because of the distance of the yards from the buyers' warehouses. Commission merchants and dealers in the markets are familiar with these conditions and when possible they request billing that will not subject their shipments to such handicaps.

Buyers may also wish to reconsign their hay upon arrival or to change the billing while the car is in transit. If the hay is shipped on a railroad line from which they can not reconsign the shipment advantageously, they may suffer a considerable loss. This loss can be charged back to the shipper if he has not followed shipping instructions.

Under certain conditions shippers may be justified in not following the consignee's instructions. In certain instances unscrupulous buyers have attached to their billing instructions certain conditions which, when the shipper has affixed his signature and thus assented to them, have deprived him of the protection to which he was entitled. When a buyer furnishes unusual shipping instructions, the shipper should, before complying with them, make certain that they will not cause difficulties or losses. Unless the shipper is certain of the reliability and financial responsibility of the commission merchant or buyer, it should be his fixed rule to bill hay only upon an order bill of lading which will prevent the buyer from gaining possession of the hay until he has paid the shipper's draft, which should represent about 75 per cent of the value of the shipment. So far as protection is concerned, however, it makes no difference whether the draft is drawn "at sight" or "upon the arrival of the car" (p. 21).

When using an order bill of lading a shipper should not sign any agreement, whether stamped upon the bill of lading or attached to it, that will in any way decrease the protection it affords.

Figures 9 and 10 show bill-of-lading forms that are properly filled out.

FORWARDING BILLS OF LADING

When the bill of lading has been signed by the railroad agent it should be forwarded promptly to the consignee unless a draft is to be attached to it, in which case it should be placed in a bank for transmittal to the consignee at the earliest moment possible. When cars are shipped only a short distance, and especially when they are billed to shipper's order, the bank should be directed to forward the draft and bill of lading promptly, preferably direct to the consignee's bank, if known, or to another bank in his town. Otherwise the shipper's bank may follow the usual custom of sending the documents through the regular channel of corresponding banks, which may delay their delivery to the consignee until after the car of hay has arrived and has been placed on demurrage.

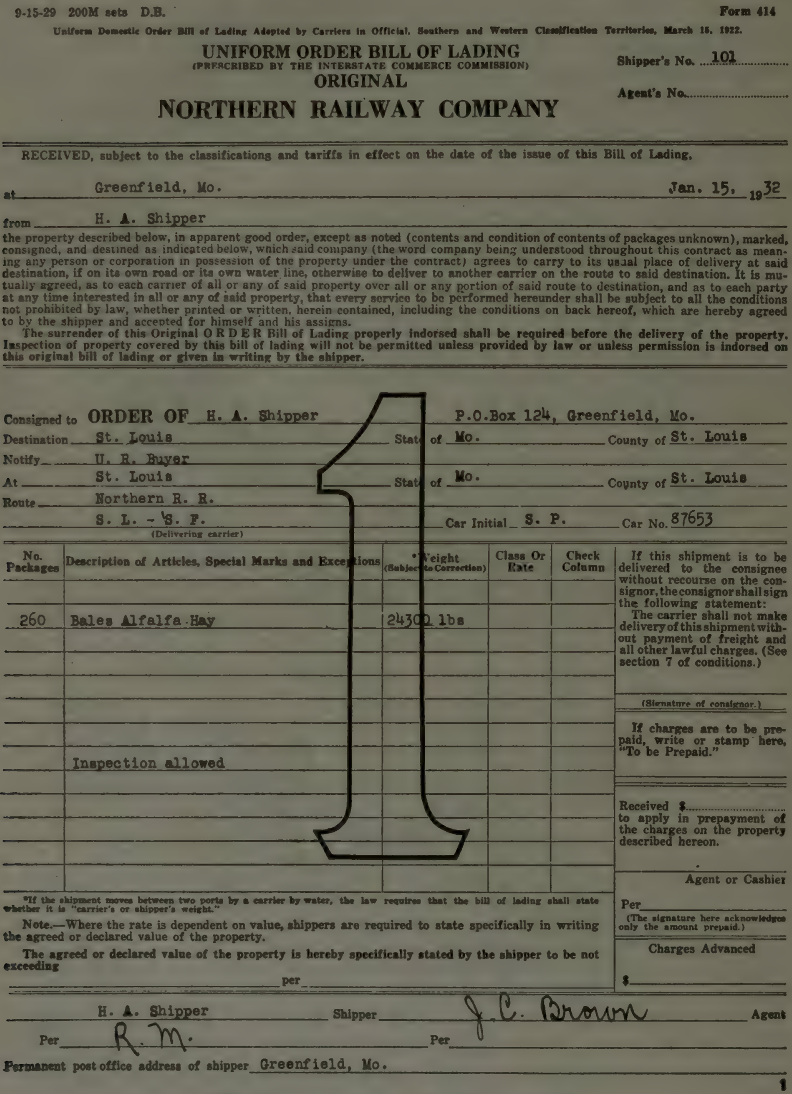
If a shipper has arranged with his bank to obtain an advance of funds on his shipment it is usually customary for him to draw a draft representing about 75 per cent of the value of the shipment and attach it to an order bill of lading. When these documents are presented to the shipper's banker, he will credit the shipper's account with the amount of the draft, and later will deduct any charges that may accrue in making collection. It is a good practice for the shipper to attach to the bill of lading an official inspection certificate, preferably a Federal inspection certificate. This evidence of quality will assist the banker in determining the value of the shipment and the amount of the advance upon the draft that he can allow the shipper. The certificate will also be of value if it becomes necessary to present a claim against the railroad for loss or damage to the hay while in transit.

If no funds are advanced, the shipper can protect himself by forwarding, for collection through a bank, an order bill of lading with a draft attached covering all or a considerable part of the value of the shipment. The railroad agent will not release the hay to the consignee until the bill of lading is presented, and this bill of lading can be obtained only by the payment of the draft accompanying it. The consignee must know the initial and number of the car if he wishes to inquire about its arrival or have the railroad trace the shipment if arrival is delayed.

Figures 11 to 15 show suggested forms for notice of consigned shipments, sight and arrival drafts, and invoices that will meet the needs of most shippers.

USING SIGHT AND ARRIVAL DRAFTS

The use of a sight or an arrival draft (figs. 13 and 14) is largely a matter of custom. In some sections sight drafts are used principally and in others arrival drafts are preferred. In most instances it makes little difference to the shipper. Each form, in connection with an order bill of lading, protects the shipper because in either case the buyer can not obtain possession of the hay (except by executing a bond to the railroad) until he has paid the draft that has been attached to and forwarded with the bill of lading through the banks. The principal difference is in the cost to the shipper. Most banks



9-15-29 200M sets D.B. **Form 414**

Uniform Domestic Order Bill of Lading Adopted by Carriers in Official, Southern and Western Classification Territories, March 15, 1922.

UNIFORM ORDER BILL OF LADING
(PRESCRIBED BY THE INTERSTATE COMMERCE COMMISSION)
ORIGINAL
NORTHERN RAILWAY COMPANY

Shipper's No. 101
Agent's No.

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading,

at Greenfield, Mo. Jan. 15, 1932

from H. A. Shipper

the property described below, in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated below, which said company (the word company being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its own road or its own water line, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed, as to each carrier of all or any of said property over all or any portion of said route to destination, and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the conditions not prohibited by law, whether printed or written, herein contained, including the conditions on back hereof, which are hereby agreed to by the shipper and accepted for himself and his assigns.

The surrender of this Original ORDER Bill of Lading properly indorsed shall be required before the delivery of the property. Inspection of property covered by this bill of lading will not be permitted unless provided by law or unless permission is indorsed on this original bill of lading or given in writing by the shipper.

Consigned to **ORDER OF** H. A. Shipper P.O.Box 124, Greenfield, Mo.
Destination St. Louis State of Mo. County of St. Louis
Notify U. R. Buyer
At St. Louis State of Mo. County of St. Louis
Route Northern R. R.
S. L. - S. F. (Delivering carrier) Car Initial S. P. Car No. 87653

No. Packages	Description of Articles, Special Marks and Exceptions	*Weight (Subject to Correction)	Class Or Rate	Check Column
260	Bales Alfalfa Hay	24300 lbs		
	Inspection allowed			

If this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement:
The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges. (See section 7 of conditions.)

(Signature of consignor.)

If charges are to be prepaid, write or stamp here, "To be Prepaid."

Received $ to apply in prepayment of the charges on the property described hereon.

Agent or Cashier

Per
(The signature here acknowledges only the amount prepaid.)

Charges Advanced
$

*If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is "carrier's or shipper's weight."

Note.—Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property.

The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding

per

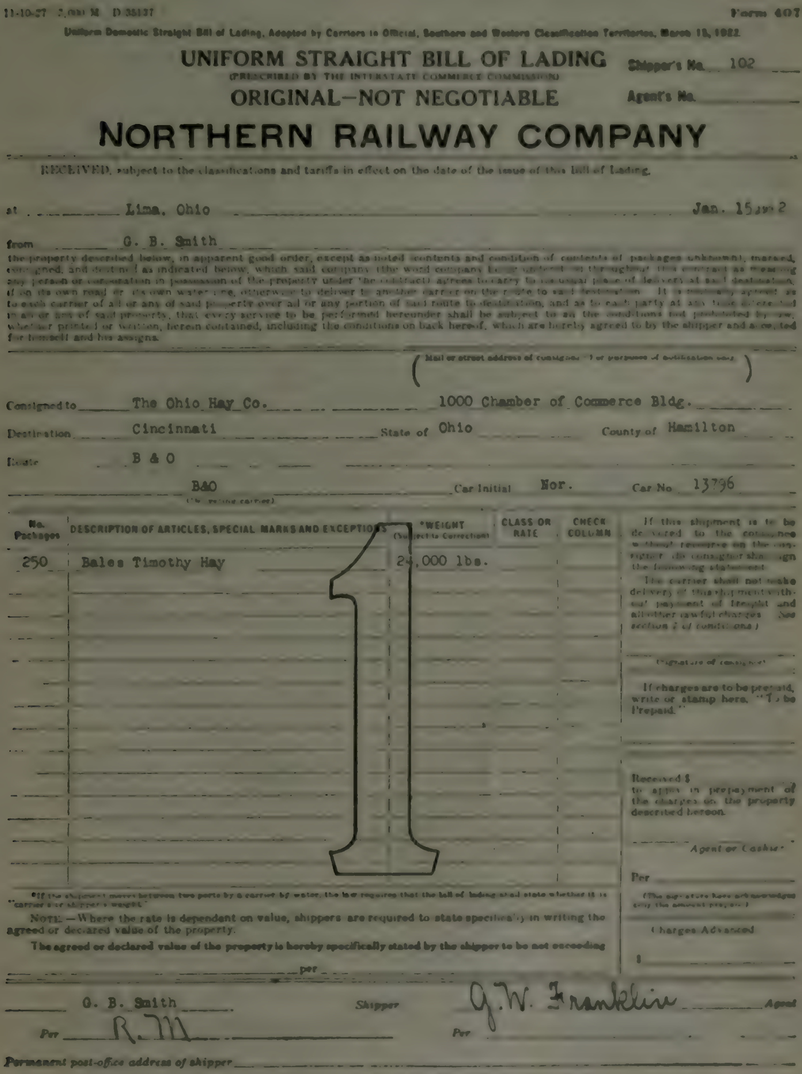
H. A. Shipper Shipper J. C. Brown Agent
Per R. M. Per

Permanent post office address of shipper Greenfield, Mo.

1

FIGURE 9.—An "order" bill of lading

allow the shipper equal credit on either kind of draft, but many banks charge interest on the amount advanced on the draft from the date the draft is deposited until the funds are returned from the corresponding bank after the draft has been paid by the buyer. The interest charge will probably be larger on the arrival draft unless the shipment is over so short a distance that the hay arrives by the time the draft reaches the buyer's bank.



11-10-27 2,000 M D 35137 Form 407

Uniform Domestic Straight Bill of Lading, Adopted by Carriers in Official, Southern and Western Classification Territories, March 15, 1922.

UNIFORM STRAIGHT BILL OF LADING
(PRESCRIBED BY THE INTERSTATE COMMERCE COMMISSION)
ORIGINAL—NOT NEGOTIABLE

Shipper's No. 102
Agent's No.

NORTHERN RAILWAY COMPANY

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading,

at Lima, Ohio Jan. 15, 192

from G. B. Smith

the property described below, in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated below, which said company (the word company being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its own road or its own water line, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed, as to each carrier of all or any of said property over all or any portion of said route to destination, and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the conditions not prohibited by law, whether printed or written, herein contained, including the conditions on back hereof, which are hereby agreed to by the shipper and accepted for himself and his assigns.

(Mail or street address of consignee—For purposes of notification only.)

Consigned to The Ohio Hay Co. 1000 Chamber of Commerce Bldg.

Destination Cincinnati State of Ohio County of Hamilton

Route B & O

B&O (Delivering carrier) Car Initial Nor. Car No. 13796

No. Packages	DESCRIPTION OF ARTICLES, SPECIAL MARKS AND EXCEPTIONS	*WEIGHT (Subject to Correction)	CLASS OR RATE	CHECK COLUMN
250	Bales Timothy Hay	24,000 lbs.		

If this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement:

The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges. (See section 7 of conditions.)

(Signature of consignor.)

If charges are to be prepaid, write or stamp here, "To be Prepaid."

Received $
to apply in prepayment of the charges on the property described hereon.

Agent or Cashier.

Per

(The signature here acknowledges only the amount prepaid.)

Charges Advanced:

$

*If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is "carrier's or shipper's weight."

NOTE.—Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property.

The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding

per

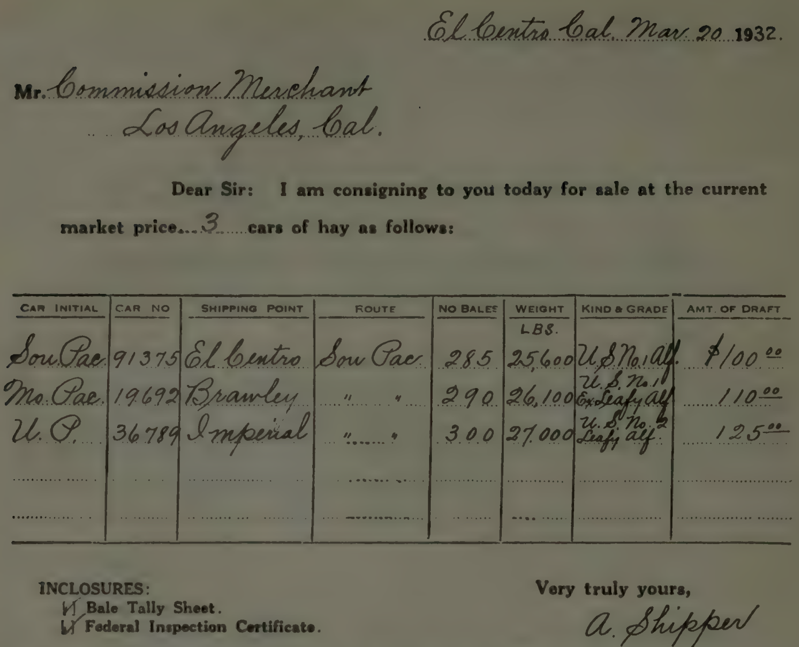
G. B. Smith *Shipper* G.W. Franklin *Agent*

Per R. M. *Per*

Permanent post-office address of shipper

FIGURE 10.—A "straight" bill of lading

If the shipper takes these charges into consideration when making quotations he can conveniently meet the wishes or custom of the buyer in the kind of draft used. It is probably only fair to the buyer to draw an arrival draft, if he requests it, so that he can inspect the hay



El Centro Cal. Mar 20 1932.

Mr. Commission Merchant
Los Angeles, Cal.

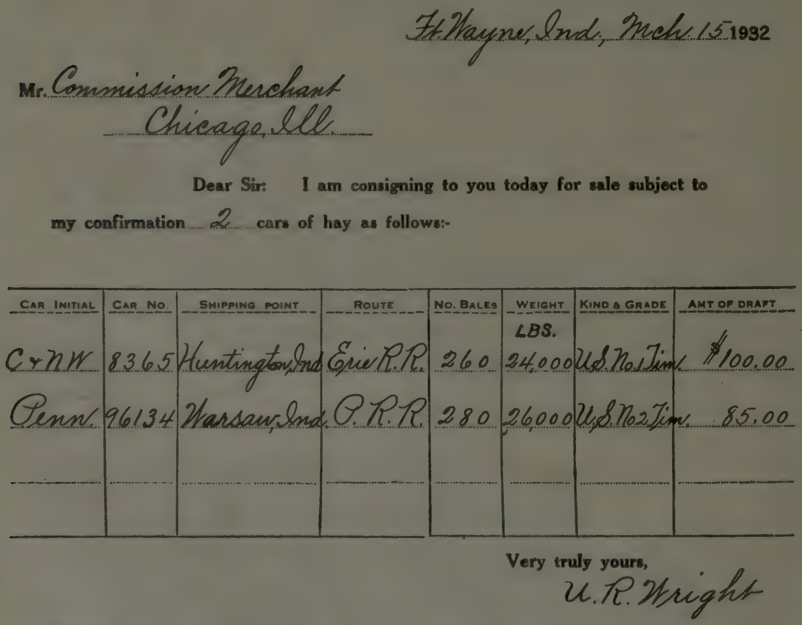
Dear Sir: I am consigning to you today for sale at the current market price 3 cars of hay as follows:

Car Initial	Car No	Shipping Point	Route	No Bales	Weight LBS.	Kind & Grade	Amt. of Draft
Sou Pac	91375	El Centro	Sou Pac	285	25,600	U.S. No. 1 Alf.	$\$100^{00}$
Mo. Pac.	19692	Brawley	" "	290	26,100	U.S. No. 1 Ex. Leafy Alf.	110^{00}
U. P.	36789	Imperial	" "	300	27,000	U.S. No. 2 Leafy alf.	125^{00}

INCLOSURES:
☑ Bale Tally Sheet.
☑ Federal Inspection Certificate.

Very truly yours,
A. Shipper

FIGURE 11.—A consignment notice in which the shipper instructs the commission merchant to sell his hay at the current market price upon arrival of car



Ft. Wayne, Ind., Mch. 15 1932

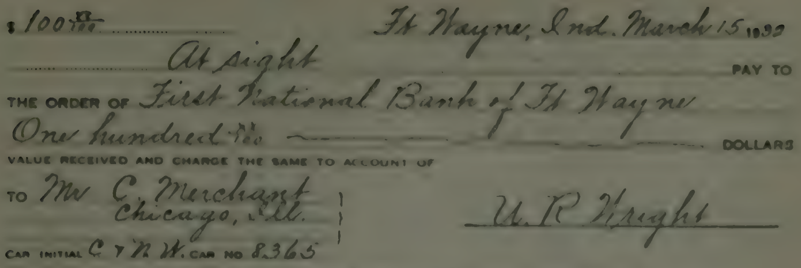
Mr. Commission Merchant
Chicago, Ill.

Dear Sir: I am consigning to you today for sale subject to my confirmation 2 cars of hay as follows:-

Car Initial	Car No.	Shipping Point	Route	No. Bales	Weight LBS.	Kind & Grade	Amt of Draft
C & N W	8365	Huntington, Ind.	Erie R.R.	260	24,000	U.S. No. 1 Tim.	$100.00
Penn.	96134	Warsaw, Ind.	P. R. R.	280	26,000	U.S. No. 2 Tim.	85.00

Very truly yours,
U. R. Wright

FIGURE 12.—Form of notice used when the shipper wishes the commission merchant to advise him concerning the price offered, before consummating the sale



$ 100 $\frac{xx}{100}$ Ft Wayne, Ind. March 15 1932

At sight PAY TO

THE ORDER OF First National Bank of Ft Wayne

One hundred $\frac{xx}{100}$ DOLLARS

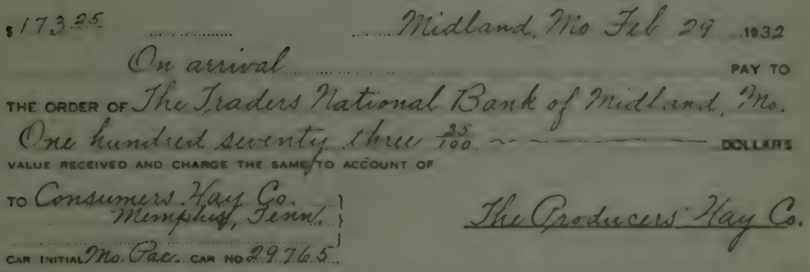
VALUE RECEIVED AND CHARGE THE SAME TO ACCOUNT OF

TO Mr C. Merchant
Chicago, Ill.

CAR INITIAL C & N. W. CAR NO 8365

U. R. Wright

FIGURE 13.—A sight draft payable upon presentation



$ 173 $\frac{25}{100}$ Midland, Mo Feb 29 1932

On arrival PAY TO

THE ORDER OF The Traders National Bank of Midland, Mo.

One hundred seventy three $\frac{25}{100}$ DOLLARS

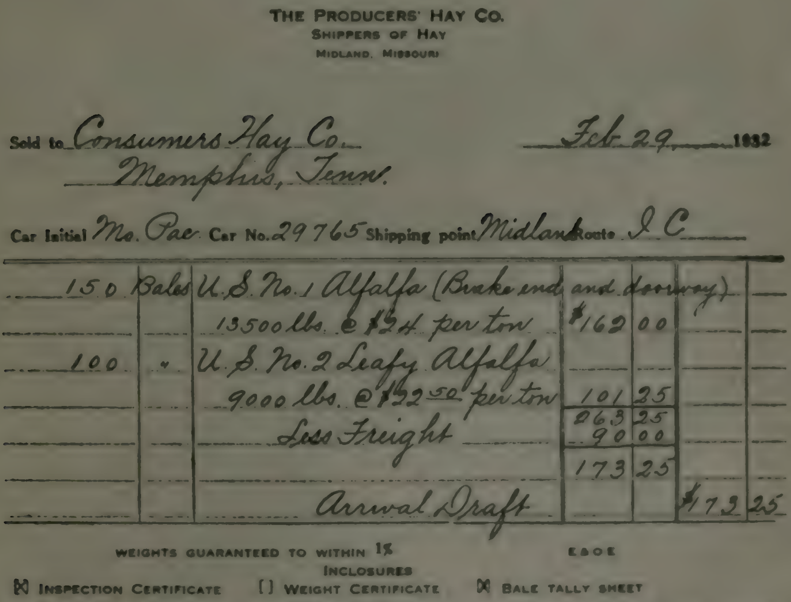
VALUE RECEIVED AND CHARGE THE SAME TO ACCOUNT OF

TO Consumers Hay Co.
Memphis, Tenn.

CAR INITIAL Mo. Pac. CAR NO 29765

The Producers' Hay Co.

FIGURE 14.—Arrival draft payable upon the arrival of the car, and allowing the purchaser time to inspect the hay before making payment



THE PRODUCERS' HAY CO.
SHIPPERS OF HAY
MIDLAND, MISSOURI

Sold to Consumers Hay Co.
Memphis, Tenn.

Feb 29 1932

Car Initial Mo. Pac. Car No. 29765 Shipping point Midland Route I C

150	Bales	U.S. No. 1 Alfalfa (Brake end and doorway)				
		13500 lbs. @ $\$24$ per ton	$162	00		
100	"	U.S. No. 2 Leafy Alfalfa				
		9000 lbs. @ $\$22^{\underline{50}}$ per ton	101	25		
		Less Freight	263 90	25 00		
			173	25		
		Arrival Draft			$173	25

WEIGHTS GUARANTEED TO WITHIN 1% E&OE

INCLOSURES

☒ INSPECTION CERTIFICATE ☐ WEIGHT CERTIFICATE ☒ BALE TALLY SHEET

FIGURE 15.—A carefully prepared invoice showing car initial and numbers, weight, price, amount of draft, and other pertinent information

before paying for it. Authority from the shipper for such inspection, however, must be indorsed upon the bill of lading if an order billing is used. Unless the terms of sale have been made definitely "shipper's track," the buyer is really entitled to inspect the hay before making payment. This is largely a matter of agreement between the shipper and the buyer, however, and therefore should be made a part of the terms of sale.

When shipments are made on straight bills of lading, drafts frequently are not drawn. The shipper awaits the arrival and sale of the car; then a settlement in full, after freight and marketing charges have been deducted, is made by the buyer or commission merchant. When the shipper does not require the advance of funds that are obtainable by means of a draft, and is satisfied of the reliability and financial responsibility of the buyer, the straight billing of hay may be more desirable, as it eliminates the bank's charges for handling the draft and any expense for demurrage, etc., which may be caused by a delay in the arrival of the draft and bill of lading at the destination of the car.

Hay frequently gets out of condition and deteriorates so that the buyer does not feel justified or financially safe in paying the full amount of the draft as drawn. In such instances, if the hay has been shipped upon an order bill of lading and a draft has been drawn for 75 or 80 per cent of the value of the shipment, it is the usual practice for the buyer to request the shipper to reduce the draft. Whether the shipper should make such reductions depends largely upon the terms of sale. If the hay has been sold "delivered" or "destination" terms, it is the duty of the shipper to deliver hay of the quality and quantity specified and to make a proper allowance for any deterioration or loss in transit. It is important, however, that the shipper assure himself that such claims are just and reasonable.

In some instances dishonest purchasers have obtained reductions on drafts when the claimed loss or damage had not occurred. Shippers must first be certain that hay of the quality and quantity contracted for has been delivered and must have adequate proof of the fact.

Federal or other official inspection at destination will provide the shipper with definite information on the condition or quality of hay upon its arrival. When buyers request reductions in drafts or a discount from the contract price, shippers should immediately request proof in the form of an official inspection certificate and should ascertain therefrom the definite quality and grade of the hay upon its arrival before allowing discounts claimed by the buyers. If an official inspection service is available the necessary information can be obtained by telegraph from the inspection agency.

If no recognized inspection service is available and the shipper has reason to doubt the validity of the buyer's claim, some disinterested person or agency should be requested to pass upon the claim before it is allowed. Railroad station agents, officials, or representatives of trade organizations, and other dealers are some of the agencies that may be called upon by shippers for assistance in checking damage claims made by hay buyers.

When the shipper is satisfied that the reduction requested is fair and reasonable, he should reduce the draft with as little delay as possible. This is done by instructing the shipper's bank to notify the corresponding bank at the destination of the car to accept the reduced amount in payment of the original draft. The shipper should not send instructions direct to the destination bank if the draft was originally deposited in the local bank, because the destination bank will make a reduction only upon authorization from its corresponding bank, which in this case is the shipper's.

If the shipper wishes to release the car to the buyer without the payment of the draft and to await settlement when the car is sold or unloaded, the procedure is the same as for reducing a draft.

MAKING THE INVOICE

When a car is consigned to a dealer in a distant market a letter to the dealer stating that a car of hay is being shipped is not enough information to enable him to arrange to the best advantage for its arrival and sale. Whether a car is consigned, sold f. o. b. shipper's track, or sold "to arrive," a carefully prepared invoice (fig. 15) should be sent to the consignee at the time the car is shipped. The invoice should show the car initial and number, date of shipment, and the kind and quality of hay, the number of bales, and the total weight. If two or more distinct kinds or grades have been loaded, the number of bales and the total weight of each kind or grade, and the location of each kind in the car, should be shown.

When a price per ton for the hay has been agreed upon on or before the date of shipment, this price, together with total value of the hay, should be shown on the invoice, also the amount of the draft and the balance due.

REBILLING CARS

Because of unsatisfactory market conditions or a dissatisfied customer, it frequently becomes advisable to reconsign hay after it has arrived at destination. The simplest method of reconsigning hay that has been shipped on an order bill of lading is to instruct the local bank at which the draft and bill of lading have been deposited to have both returned. The shipper can then take the original bill of lading, surrender it to the railroad agent, rebill the car to the new destination, and obtain a new bill of lading.

But if the car is at a distant point, the demurrage charges that would accrue while the bill of lading was being returned and a new one issued would grow large. To avoid these charges it is possible to arrange with the local railroad agent for the issuance of a new bill of lading before the first is returned. This is done by furnishing a bond for the protection of the railroad company against any claim based upon the first bill of lading that may arise before the bill of lading has been returned to the railroad agent and been canceled. Upon the execution of this bond the local agent will immediately telegraph to the agent at destination and instruct him to forward the shipment according to the new billing. Freight and other charges may be allowed to follow the shipment and may be paid at final destination. Shippers should avail themselves of this provision when it seems advantageous to reconsign a shipment

LOSS AND DAMAGE CLAIMS

However carefully shippers may weigh and load their hay, some losses due to accidents or carelessness on the part of the carriers or marketing agencies are sure to occur. When a shipper has agreed to deliver a certain quantity of hay of a certain quality, the buyer, of course, expects the hay to meet the conditions of the sale; or he expects to receive an allowance or reimbursement for any difference in value between the hay bought and that delivered. The shipper's only recourse then is to collect for the damage or loss from the agency responsible for it.

Some commission merchants maintain "traffic departments" which handle claims for their shippers. Trade organizations also maintain claim bureaus and will undertake to collect claims for members for a nominal sum or upon a commission basis. These agencies can be of great assistance to shippers. Some buyers make a practice of making claims upon the railroads for alleged losses when there is considerable doubt whether the losses were in any way caused by the negligence of the carriers. Such claims are usually disallowed by the railroads.

PREPARATION OF SHIPPERS' CLAIMS

With the exception of intricate cases, which may require legal advice, most claims can be presented by the shippers as well as by any other party. If properly prepared, a claim presented by the shipper will be considered as promptly by the responsible agency as one presented by a dealer or trade representative.

Proofs of the loss or damage are necessary in the preparation of claims. Many railroads have special "overcharge" and "loss and damage" forms, which will be furnished upon request. The documents usually required to establish proof of claims are:

(1) A copy of the original invoice and a copy of the bill of lading upon which the shipment was made.

(2) The paid freight bill receipted by the railroad agent at destination.

(3) In loss claims, sworn detailed statements of loading and unloading weights, showing the number of drafts in which hay was weighed both into and out of car and the bale count at both the time of loading and that of unloading.

(4) In damage claims, official inspection certificates and reports on the physical conditions of the car at the time of loading and unloading. When official inspection certificates are not available sworn statements on the quality and condition of the hay when put into the car and when unloaded from the car are required.

Claims must be presented within six months of the time the loss or damage occurs. Unless shippers can establish proof of the loss or damage, as outlined here, it is doubtful whether the claims will be allowed by the carriers. Only about 50 per cent of the claims presented to carriers are paid, and this indicates that many of them lack the necessary proof or are improperly prepared. Shippers will save expense and trouble by not presenting claims that are inadequately supported or improperly prepared.

Buyers frequently make claims upon the shippers for losses, shrinkage, or errors in weight, and for discounts because of the inferior quality of a part or the whole of a carload. Legitimate claims should be paid promptly; but before making payment a shipper should require the buyer to furnish conclusive proof of the losses claimed.

Claims based upon a misunderstanding of terms of sale are usually more difficult than others to adjust. If such a claim can not be settled by friendly correspondence or by a personal visit from one party to the other, it is usually advantageous to both parties to submit the dispute to disinterested parties for arbitration and settlement.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	Henry A. Wallace.
Assistant Secretary	Rexford G. Tugwell.
Director of Scientific Work	A. F. Woods.
Director of Extension Work	C. W. Warburton.
Director of Personnel and Business Administration.	W. W. Stockberger.
Director of Information	M. S. Eisenhower.
Solicitor	Seth Thomas.
Bureau of Agricultural Economics	Nils A. Olsen, *Chief.*
Bureau of Agricultural Engineering	S. H. McCrory, *Chief.*
Bureau of Animal Industry	John R. Mohler, *Chief.*
Bureau of Biological Survey	Paul G. Redington, *Chief.*
Bureau of Chemistry and Soils	H. G. Knight, *Chief.*
Office of Cooperative Extension Work	C. B. Smith, *Chief.*
Bureau of Dairy Industry	O. E. Reed, *Chief.*
Bureau of Entomology	C. L. Marlatt, *Chief.*
Office of Experiment Stations	James T. Jardine, *Chief.*
Food and Drug Administration	Walter G. Campbell, *Chief.*
Forest Service	R. Y. Stuart, *Chief.*
Grain Futures Administration	J. W. T. Duvel, *Chief.*
Bureau of Home Economics	Louise Stanley, *Chief.*
Library	Claribel R. Barnett, *Librarian.*
Bureau of Plant Industry	William A. Taylor, *Chief.*
Bureau of Plant Quarantine	Lee A. Strong, *Chief.*
Bureau of Public Roads	Thomas H. MacDonald, *Chief.*
Weather Bureau	Charles F. Marvin, *Chief.*

U. S. GOVERNMENT PRINTING OFFICE: 1933

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents

DATE DUE

Sep 16'39
Ju28'41
Nov 10 43
Jan 29'48
Mar 20'48
Oct 6 50

NOT FOR CIRCULATION

606 Us2age
v. 74
U.S. Dept. of agric.
Farmer's bulletins

Providence
Public Library
SCIENCE AND INDUSTRY DEPT.

To take a book from the Library without having it charged is an offense against the rights of other readers, and a violation of the rules of the Library and the laws of the State.

Examine this book carefully before taking it home. If found to be damaged or needing repairs, report it. Otherwise, you will be held responsible for its condition.